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Research Report 1745

Prototype Staff Training and Evaluation Methods for Future Forces

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U.S. Army Research Institute for the Behavioral and Social Sciences

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Director

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14. ABSTRACT *(Maximum 200 words)*:

The purpose of this report is to document the design, development, and demonstration of a prototype training package to improve staff performance and a prototype performance evaluation package for staffs using advanced command, control, communications, computer, and intelligence (C^{4}I) systems. These prototypes were implemented in a simulation-based experiment to examine the impact of digital systems on future Battle Command at the battalion and brigade level. This report first presents a review of previous research and relevant literature on training design and evaluation issues. The design and development of the prototype training and evaluation packages are described and are followed by discussions of formative results and lessons learned. The major research products associated with training and evaluation for the implementation are presented in the five-volume set of materials entitled *Training and Measurement Support Package, Battle Command Reengineering III, Mounted Maneuver Battlespace Lab.* The formative evaluation provided valuable information for revisions and additional trials of the prototype training and evaluation package are required to validate its efficacy and utility. Future implementation should lead to further development of this prototype training and evaluation package that targets higher-order cognitive skills needed on the digital battlefield.

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Personnel Performance and Training Technology

FOREWORD

The Future Battlefield Conditions (FBC) Team of the Armored Forces Research Unit, U.S Army Research Institute for the Behavioral and Social Sciences (ARI) has a Science and Technology Objective (STO) entitled "Force XXI Training Strategies." This STO is also reflected in the FBC work package (2228) FASTRAIN: Force XXI Training Methods and Strategies. Recent work under this work package has involved research and development concerning training for digital staffs. In order to continue this work, a contract entitled "Prototype Methods for the Design and Evaluation of Training and Assessment of Digital Staffs and Crewmen" was issued. The major purpose of this effort was to design, develop and implement prototype training and assessment techniques for future, information age, staffs.

This report concerns research focused on training and assessment for future staffs. It describes an examination of theories of team training applicable to information age staffs. The report documents the design and development of prototype training and assessment methods based on those theories. The report examines implementation of the prototype techniques in a battalion level Battle Command Reengineering (BCR) III experiment, conducted by the Mounted Maneuver Battlespace Lab located at Fort Knox, KY. Lessons learned from both the examination and implementation of these theories of team training are also discussed.

At least two major audiences may be interested in this report. Researchers interested in the area of training for information age staffs will find an examination of relevant team training theories, and prototype training and assessment methods rooted in those theories. Also, the report may be of interest to training developers, in that it describes an effort to implement digital staff training in a specific context (BCR III). Thus this report may prove useful in future research and development efforts for training of information age staffs.

The prototype products developed under this effort are documented in a five-volume set of materials entitled *Training and Measurement Support Package, Mounted Maneuver Battlespace Lab, Battle Command Reengineering*, available from the Mounted Maneuver Battlespace Lab (MMBL). Training and evaluation findings from this effort are included in the MMBL's *Battle Lab Experiment Final Report (BLEFR) for Battle Command Reengineering, Phase III* (1999).

The research reflected in this report was briefed to sponsors throughout the effort and in a final In Progress Review, held at Armored Forces Research Unit, Fort Knox, KY, on 8 June 1999.

Zita M Simutis

ZITA M. SIMUTIS
Technical Director

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Additionally, we had support and guidance from a variety of individuals and government organizations, including:

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- 2nd Squadron, 2nd Armored Cavalry Regiment - Fort Polk, LA
  Lieutenant Colonel Mark Littel, Commander

PROTOTYPE STAFF TRAINING AND EVALUATION METHODS FOR FUTURE FORCES

EXECUTIVE SUMMARY

Research Requirement:

The U. S. Army is currently developing and fielding information systems for the digital battlefield of the future. In support of this effort, the U. S. Army Research Institute for the Behavioral and Social Sciences (ARI), Armored Forces Research Unit, Future Battlefield Conditions Team is engaged in the design and development of training and performance evaluation techniques. For this project, ARI's objective was to design team training and assessment strategies for staff operations in the future digital tactical operations center at brigade and below. In order to accomplish this objective, the team designed and developed two primary products: a prototype training package to improve staff performance and a prototype evaluation package.

The prototype products were implemented during the Battle Command Reengineering (BCR) III Concept Experimentation Program (CEP) experiment at the Mounted Maneuver Battlespace Lab (MMBL) at Fort Knox. The ARI's purpose for participating in this experiment was to gain additional information on future staff training requirements, gather feedback for improvements to the prototype training package, and gain experience with specific automated measures of performance and effectiveness in a virtual simulation environment.

Procedure:

Previous ARI research on structured training programs provided the model for the development of the training support packages. The project team also reviewed available literature regarding training, team performance, and measurement issues. This review included study of the U. S. Army Training and Doctrine Command (TRADOC) Digital Learning Strategy (Department of the Army, 1998) and associated training strategies and approaches, professional psychological publications, training and education literature, tactical operations, and command and control operations. This literature review provided the basis for decisions concerning training structures and content, measures design, and analysis procedures.

An extensive front-end analysis was conducted to define future battalion-level staff processes in terms of individual and node responsibilities, specific nodes tasks and requirements, command, control, communications, computer, and intelligence (C^4I) systems capabilities, and individual functions and tasks using C^4I tools. After analysis, structured training exercises were designed and developed that combined C^4I system practice with techniques to focus team training on shared situational awareness, roles and functions, and decision-making processes.

The approach to performance evaluation was multifaceted, combining automated measures, surveys, observations, and interviews. The measurements focused on various issues

concerning command and control, team processes and decision-making, team roles and responsibilities, workload, and communication.

The prototype training and evaluation packages were partially implemented during the BCR III experiment, which took place 12 April through 30 April 1999. The experiment was conducted in the MMBL test bed at Fort Knox with the 2nd Squadron, 2nd Armored Cavalry Regiment from Fort Polk participating. The major research products associated with training and evaluation for the MMBL implementation are presented in the five-volume set of materials entitled *Training and Measurement Support Package, Battle Command Reengineering III, Mounted Maneuver Battlespace Lab* (Mounted Maneuver Battlespace Lab, 1999).

Findings:

During the trial implementation of the prototype training package, the challenges and stresses associated with learning the new organization, equipment, tactics, and C^4I system overrode the team training sessions. A major finding was that additional analysis is required to determine if this type of training should be done in conjunction with learning to operate an advanced C^4I system or if these sessions should be implemented in a less demanding operational environment where the benefits of incorporating them into staff training (which are described in the theoretical literature and were recognized by some of the training participants) can be fully realized. Additional findings related to team training sessions include: a) using a facilitator from outside of the unit to implement these sessions; b) revising the information management training session; and c) revising the titles of the team training sessions to reflect current Army terminology. In findings related specifically to the prototype training package, additional refinement of the training design is needed in three areas: organization, time allocation, and training audience.

Considerable research remains to be done on developing both performance standards and evaluation methods for future battle staffs operating advanced C^4I systems. While surveys, observations, and interviews were used to gather data during the pilot implementation, the project team made a major effort to develop automated measures that could take advantage of the analytical power and processing speed of advanced C^4I systems to provide real or near real-time feedback to the training participants. This effort was only partially successful. Further research is required to determine the specific measures and processes needed to extract data from advanced C^4I systems or simulations in an easily interpretable format suitable for performance feedback.

Utilization of Findings:

These findings provide insights regarding the impacts of future C^4I systems on the Battle Command process. The specific audience who may find the information contained in this report beneficial includes: a) training program designers, developers, and implementers; b) simulation system developers (hardware and software); and c) training unit and training site personnel. Training and evaluation findings from this effort are included in the MMBL's *Battle Lab Experiment Final Report (BLEFR) for Battle Command Reengineering, Phase III* (Mounted Maneuver Battlespace Lab, 1999b).

PROTOTYPE STAFF TRAINING AND EVALUATION METHODS FOR FUTURE FORCES

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PROTOTYPE STAFF TRAINING AND EVALUATION METHODS FOR FUTURE FORCES

Introduction

The transition to the digital Army of Force XXI and beyond is characterized by challenges to how the Army will train, maintain, and operate as an information age force. The future Army will have an increased area of operation; combined arms for close combat with fewer systems; non-linear, asymmetrical operations; and operational requirements for situational awareness. The future force will depend on the capabilities of its command, control, communication, computer, and intelligence (C^4I) systems, and on the ability of the commanders and staffs to fully understand and utilize the systems.

The battalion and brigade staff of the future Army may well be a considerably different entity from that which is known today. Staffs operate on information. By radically increasing the amount and timeliness of information received by the staff, the functions, organization, capabilities, and requirements of the staff will also have to change. But staffs are complex organizations, and it cannot be presumed that simply adding computers and digital communications capabilities will provide simple answers to how a future staff will be organized and what tasks it will perform.

With the advanced C^4I systems, information processing takes on new importance. Information processing is a component of decision-making in every aspect of planning, preparation, execution, and reconstitution. As they make decisions, leaders are continuously dealing with updates to staff estimates, enemy situations, and higher headquarters directives. Digital information systems will almost certainly increase the amount and complexity of information provided to the staff, and training should provide the higher-order skills needed on the digital battlefield. "Better education and training, devoted to information processing under stress and in environments characterized by uncertainty, are needed to develop the necessary skills to handle these information-rich situations" (Alberts, 1996, p. 32).

There are a number of concepts in the current and recent research literature related to "information-rich situations" and the challenges they pose. In addition to the problem of information management, researchers have been examining the impact of increased information on decision-making, situational awareness, and team behaviors. Within the various models that are being developed to explain how experts and teams might handle information-rich situations, there are also indications of performance techniques, ways to train and educate, and ways to ascertain skill acquisition and proficient performance. This last issue, concerning performance evaluation, is critical to training, but is often overlooked. Evaluation that supports both training analysis and feedback mechanisms for the participants is needed.

In response to the concerns and issues resulting from digitization, the U. S. Army Research Institute for the Behavioral and Social Sciences (ARI), Armored Forces Research Unit, is engaged in the design and development of training and performance evaluation techniques to support Force XXI digital capabilities. The ARI's research in this area includes recent advances in the cognitive and behavioral sciences, and is focused on providing an empirical foundation for improved team training and evaluation strategies for the digital battlefield of the future.

This report details work performed in support of that objective by the contractor consortium of the Human Resources Research Organization (HumRRO), Litton-PRC, Klein Associates, and Aptima. Specifically, the objective of the research project was to design team training and evaluation strategies for staff operations in the future digital tactical operations center at brigade and below. The research addresses methods for training leaders and staffs of future digital environments: the content of such training, the methods for providing the training, and the means for assessing performance outcomes as a result of training.

The work began with a review of research literature and technical documentation related to team performance and training, operations in digital environments, and automated performance data collection. A general design for staff training was formulated, based on synthesis of the literature review. This design was then tailored to provide training in support of an upcoming Army experiment, the Battle Command Reengineering (BCR) III, which took place in April 1999. By participating in the BCR III, researchers had the opportunity to conduct a trial implementation of the training and evaluation package. Coordination between ARI and the Mounted Maneuver Battlespace Lab (MMBL) at Fort Knox, Kentucky enabled the two organizations to work together as a team to accomplish multiple goals. This report describes the development work and the prototype products, results of their use during the BCR III, and implications for future training, both within MMBL settings and in the larger context of staff training.

Organization of the Report

This report has five sections:

- *Introduction:* Summary of previous research and relevant literature on training and evaluation designs.
- *Prototype Training and Evaluation Methods:* Description of the front-end analysis, design, and products for future staff training and evaluation; description of the BCR III for which prototype development and trial implementation were conducted.
- *Formative Results:* Description of the BCR III implementation; results and discussion concerning training and measures evaluation.
- *Lessons Learned for Future Research:* Summary of the major lessons learned concerning training and evaluation with implications for future MMBL experimentation and further research.
- *Summary and Conclusions:* Brief review of the project's objectives and accomplishments.

Appendix A contains a listing of the acronyms and abbreviations used in this report. Samples of training and evaluation products developed for the prototype training package and trial implementation are contained in Appendixes B through F. In addition to this report, the major research products associated with training and evaluation for the MMBL implementation are presented in the five-volume set of materials entitled *Training and Measurement Support Package, Battle Command Reengineering III, Mounted Maneuver Battlespace Lab* (Mounted Maneuver Battlespace Lab, 1999c). The five volumes are:

- *Volume 1. Front-End Analysis for Training and Measurement.* Contains all of the front-end analysis products developed for the prototype training package for BCR III.
- *Volume 2. Initial Orientation and Train-Up.* Includes sample slides prepared for the MMBL briefing to the participating unit in BCR III, training plan outlines for initial and advanced digital system training, and materials for the first two team training sessions.
- *Volume 3. Tactical Decision-Making Exercises and Team Training Sessions.* Contains the training support package (TSP) materials for the structured training exercises and team training developed as a prototype for use in BCR III.
- *Volume 4. Measures.* Includes copies of all surveys and structured interview forms, descriptions and screen copies from the observer data collection instrument, and specifications for the automated measures used in BCR III.
- *Volume 5. Data Codebook.* Contains basic descriptions and analyses of the variables in the data sets resulting from the data collection in BCR III.

Background

The purpose of this section is to provide the context for the project and the rationale for the approach to training and evaluation. It summarizes the research literature on a variety of topics related to military staff and team performance. The literature reviewed includes results of earlier MMBL experimentation, both because the findings were important in shaping the general training design, and because the MMBL setting was selected for the development and implementation of the prototype training package described later in this report.

There were three major aspects of training that were examined within the literature: *what* to train, *how* to train, and *how to provide feedback.* First, because the focus was on staff training in a digital environment, the literature on various aspects of team performance in information-rich environments was examined. Second, the structure of the training, in terms of the order of presentation, pace, and delivery mode, was examined in relation to the content areas. Finally, the literature on various methods for obtaining data, both to assess training quality and to provide feedback, was explored.

Training Methods and Models

In reviewing the literature on team training, four common content themes were apparent: decision-making models, team skills (particularly shared mental models), information processing, and situational awareness. Because of the changes in staff structures made possible by the more advanced equipment, decision-making procedures are likely to be modified, and familiar mental models shared by staffs will need to be reexamined. The advanced digital environments will provide more information, more accurately and more quickly, which will accelerate decision-making while stressing information-processing protocols. The potential for improved situational awareness will only be realized if staffs can recognize and process information relevant to the situation at hand. Thus, all of these content areas were deemed to have particular relevance to the challenges and opportunities within the reengineered staff and advanced C^4I environments.

Decision-making processes. Army training in the staff decision-making process has not fully utilized the potential that digitization can bring to battle command, especially at the brigade and battalion tactical levels (Campbell, Deter, et al., 1999). The current thrust of Army digitization has been to speed up the decision-making process rather than improving the quality of decision-making. The following discussion reviews traditional models of decision-making as well as more recent theories of the process. Each body of theory is also associated with specific training techniques for improving decision-making skills.

Researchers studying traditional decision-making have attempted to identify a generic decision-making process that can be used successfully in a variety of contexts. These training efforts have been directed toward how best to teach a set of generic decision-making strategies. The theoretical model underlying the traditional decision-making process assumes the decision maker is a rational/economic human (Simon, 1956) or vigilant decision maker (Janis & Mann, 1977) who systematically searches for relevant information in an unbiased manner and then carefully weighs the utility of each alternative before making a choice. Early training efforts focused on how to train people to use decision analytic techniques to select the best alternative course of action. Increasingly, however, the research demonstrated that human decision-makers often fail to follow the prescriptions of normative models.

As a result, training efforts became focused on how to unbias decision makers. Baron and Brown (1991) provide an excellent review of the traditional decision skills training programs that have been implemented with students. Although their book focuses on how to improve adolescents' decision-making ability, their model, which they call Personalized Decision Analysis (PDA), is also used by adults as documented in a variety of settings. The PDA model assumes the decision-maker is faced with a choice between options (i.e., courses of action) and needs to estimate the uncertainty of the possible outcomes associated with each option. Decision-makers are also required to judge the desirability of each outcome in terms of the expected utility to be gained or lost should this outcome occur. The mathematical formulas of statistical decision theory (Savage, 1954) are then used to determine the option with the highest value based on the probability-weighted utility of its outcomes (Raiffa, 1968).

One of the most extensive decision training programs developed from the decision analytic perspective is the Goals, Options, Facts, Effects, and Review (GOFER) course developed by Mann and his colleagues (Mann, Beswick, Alloache, & Ivey, 1989; Mann, Harmoni, & Power, 1991; Mann, Harmoni, Power, Beswick & Ormond, 1988). The GOFER course is based on Janis and Mann's (1977) conflict theory of decision making which claims that the ideal decision-making process is that of the "vigilant" decision-maker. Mann et al. (1991) explain that the acronym GOFER is formed from the five criteria for vigilant decision-making:

- goals (surveying values and objectives),
- options (considering a wide range of alternative actions),
- facts (searching for information),
- effects (weighing the positive and negative consequences of the options), and
- review (planning how to implement the options).

Mann and his colleagues note that additional evaluation studies are needed to determine whether or not the decision skills taught in the GOFER course will transfer to real-life settings.

There has been limited success in establishing the effectiveness of decision-skills training programs based on studies of traditional decision-making (Fallesen & Pounds, 1998). Although several controlled experimental studies have been able to demonstrate changes in decision-making behavior in a laboratory or classroom context, it is unclear whether or not these results will generalize to a real-world environment. Recently, decision researchers have questioned whether it is appropriate to attempt to unbias decision-makers when the biases may only exist in artificial, laboratory settings. For example, Gigerenzer (1991) demonstrated that the overconfidence bias that has been frequently documented in the laboratory may disappear when the decision tasks are presented in more meaningful ways. If decision-makers in real-world settings do not suffer from the overconfidence bias, then training that attempts to remedy this bias is irrelevant.

The Army's Military Decision-Making Process (MDMP) has many of the characteristics of earlier decision-making theories discussed by Simon (1956) and Janis and Mann (1977). As described in Field Manual (FM) 101-5 *Staff Organization and Operations* (Department of the Army [DA], 1997a), the MDMP is an analytical process for military problem solving. It involves problem definition, delineation of alternative scenarios and ways to counter each alternative, and weighing of the pros and cons to ascertain the most advantageous decision. The MDMP is a viable model for decision-making under specific (and usually rare) conditions: when options are fairly clear-cut, and when there is sufficient time to wargame alternative decisions. While learning the MDMP is not difficult, mastering and using it effectively are problematic. More often than not, the pressures of mission, enemy, terrain, friendly troops, time, and civilian considerations (METT-TC) force shortcuts or unintended alterations. The unreliability and incompleteness of available information about the current situation and changing conditions have always induced uncertainty into the military decision-making process.

With the advent of digital technologies, uncertainty should, theoretically, be reduced. The MMBL's BCR I was designed to evaluate ways to help the commander achieve his need to visualize the battlefield and to examine the training that would be required for future operations (Elliott, Sterling, & Lickteig, 1998; MMBL, 1998a). One important finding from this BCR I was that several steps of the MDMP were performed in a faster, more parallel, and less formal style and that this was somewhat more effective and efficient than the current MDMP. In the second BCR, the MDMP was again noticeably altered and resulted in an even more streamlined process compared to the first BCR (Elliott, 1998).

Research began to emerge in the 1980s that focused on how experts made decisions in their natural environments or in simulations that preserved key aspects of their work environments. The general decision-making model, referred to as naturalistic decision-making (NDM), provides a basis for explaining decision-making processes in environments where awareness of the current situation changes very quickly. In contrast to traditional research in laboratory settings, NDM researchers discovered that experienced decision-makers spend more time and effort sizing up the situation, than comparing alternative options or solutions. Zsambok (1997) defines NDM as follows:

> The study of NDM asks how experienced people, working as individuals or groups in dynamic, uncertain, and often fast-paced environments, identify and assess their situation, make decisions and take actions whose consequences are meaningful to them and to the larger organization in which they operate. (p. 5)

Cohen, Freeman, and their colleagues (Cohen, Freeman, & Thompson, in preparation; Cohen, Freeman, & Wolf, 1996) have developed critical thinking skills training based on the NDM perspective. This training focuses on tactical decisions made by naval officers in a ship's Combat Information Center (CIC). Its development is based on interviews conducted with naval officers who described their CIC experiences in actual combat situations such as the Gulf War (Kaempf, Klein, Thordsen, & Wolf, 1996).

Cohen et al. (in preparation) acknowledge that for some situations in the Combat Information Center (CIC) there is no time to deliberate over the most appropriate action (e.g., in situations that involve immediate threat to own ship). In such situations, a recognition-based decision model, such as Klein's Recognition Primed Decision (RPD) model (1997), provides a good description of the expert decision-maker's thinking. However, Cohen et al. argue that in other situations there is adequate time to deliberate about the decision problem, and it is on these situations that their training focuses. An important part of Cohen et al.'s critical thinking training involves the critiquing process. Decision-makers are taught how to use a devil's advocate technique to uncover hidden assumptions in their stories. Decision-makers are told that an infallible crystal ball indicates that their current assessments are wrong and encourages them to explain how that could be the case. This technique alerts the decision-maker to consider significant alternative explanations for the current evidence.

Cohen et al. (in preparation) describe their efforts to evaluate the effectiveness of their critical thinking training. A total of 95 military officers (a mix of Navy, Marine, Army, and Air Force) participated in two separate studies. They assessed the effectiveness of the training by having participants complete questionnaires about a scenario similar to scenarios used during training. The participants played the role of the Tactical Action Officer in the CIC. Support for the effectiveness of the critical thinking skills training was reflected in comparisons between trained and untrained officers on measures such as the number of conflicting items generated, and the number of alternative explanations generated. In addition, the accuracy of the participants' assessments was evaluated by comparison to the assessments of a subject matter expert (SME). In general, across these different measures, the critical thinking skills training was demonstrated to increase the quality of the officers' decision-making skills.

One of the more comprehensive cognitive skills training programs developed to date in an Army context was developed by Fallesen and his colleagues at ARI (Fallesen, 1995; Fallesen, Michel, Lussier, & Pounds, 1996). They call their training "Practical Thinking" to contrast it with theoretical or formal methods. Practical Thinking training focuses on cognitive processes directed toward a goal and performed in specific circumstances. The Practical Thinking training developed by Fallesen and his colleagues includes aspects of both critical and creative thinking; participants are trained to think analytically and critically, but are also encouraged to be innovative and "daring." The researchers developed course materials which included lessons on multiple perspectives (i.e., thinking outside the box), metacognitive skills that allow the

individual to guide his or her thinking deliberately, techniques for identifying hidden assumptions, practical reasoning techniques (e.g., demonstrations of reasoning fallacies), and integrative thinking techniques to increase participants' understanding of the relationships among events and concepts.

In summarizing the lessons learned from administration of the Practical Thinking training, Fallesen et al. (1996) concluded that Practical Thinking training was well received by the majority of the participants. However, they acknowledged that "Practical Thinking is not so much taught as it is modeled and encouraged by instructors and self-learned by students" (p. 89). Therefore, they recommended that future cognitive skills training should augment class time with increased practical exercise assignments to be completed by students outside of the classroom. Fallesen et al. also suggested that future research is needed to develop a comprehensive technique to evaluate the effectiveness of cognitive skills training.

The latest revision to the Army's MDMP incorporates some of the techniques of NDM into its discussion of how commanders can accelerate the decision-making process in a time constrained environment. Four techniques that assist in accelerating the process include: a) expanding the commander's direct involvement in the decision-making process; b) having him issue more directive guidance to his subordinates; c) limiting the number of courses of action to be developed and war-gamed; and d) maximizing parallel planning among the staff and with subordinate units (DA, 1997a). These techniques parallel the previously discussed literature about how expert decision-makers operate.

Recently, there have been increasing efforts to apply principles of NDM to the training of cognitive skills of various teams, including battle command staffs (e.g., Klein, Orasanu, Calderwood, & Zsambok, 1993; Klein, 1998; Flin, Salas, Strub, & Martin, 1997; Zsambok & Klein, 1997). In particular, the naturalistic framework seeks to train decision skills in context. Rather than trying to teach a generic method, researchers (e.g., Klein, Kaempf, Wolf, Thordsen, & Miller, 1997; Klein, McCloskey, Pliske, & Schmitt, 1997) have described the importance of identifying the decision requirements of a task: the difficult and critical decisions, the reasons for their difficulty, and the cues and strategies used to handle them.

A model and training process referred to as Advanced Team Decision-Making has been used by Klein Associates since 1992 (Zsambok, Klein, Kyne, & Klinger, 1992). In their observation and analysis of teams in a variety of settings, they found few advanced teams, defined as teams that had reached their full potential. And the teams that did perform well were unable to describe what they did or reliably replicate that performance in other instances. The researchers therefore described a decision-making model with several critical behaviors that distinguish high performance teams from less productive ones. The model proposes three basic components of advanced team decision-making: team identity, team conceptual level, and team self-monitoring. Strong team identity is associated with a shared understanding of individual roles and functions; active participation by all team members; compensating behaviors that ensure that team goals are achieved; and avoiding micro-management throughout the team. Team conceptual level refers to the extent to which the team thinks, solves problems, makes decisions, and takes actions collectively on a level of complexity and sophistication that matches the demands of the task. Teams with high conceptual levels are able to envision common goals

and plans; focus their decision-making within an appropriate span of time and on relevant concepts and information; discover and fill holes in the information and assumptions and recognize and handle inconsistencies; and accommodate divergent views and arrive at converging plans. Team self-monitoring refers to the team's ability to observe itself for consistently high team identity and conceptual levels. It involves both the ability to adjust based on circumstances and the ability to manage time effectively. The model and training program formed the basis for training at the Industrial College of the Armed Forces using highly structured low-fidelity simulations as well as National Security Strategy Exercises.

The theoretical foundation for applying NDM to the decision skills training used by Klein, McCloskey, et al. (1997) draws directly from the research literature on expert-novice differences (Dreyfus, 1972; Dreyfus & Dreyfus, 1986; Ericsson, 1996; Hoffman, 1992). There are a variety of differences that separate novice, or near-novice performers from highly skilled ones. These include differences in the quantity and organization of what is known, differences in how information is sensed and responded to, and differences in problem-solving and reasoning strategies (Chi & Bjork, 1991; Ericsson & Smith, 1991; Ford & Kraiger, 1995; Glaser, 1990; Klein & Hoffman, 1993). Moreover, the special knowledge and skills that expert performers possess are not general ones, but are specific to the tasks and domain in which they are learned and used (Feltovich, Ford, & Hoffman 1997).

In trying to identify the strategies skilled performers use to develop their expertise, the work of Klein and his associates was particularly relevant. Klein, McCloskey, et al. (1997) developed Decision Skills Training workshops that require the participants to practice using these strategies. They have presented these workshops to urban and commercial firefighters, and officers and enlisted personnel in the U. S. Marine Corps (USMC). Most of these workshops have been conducted for the USMC, and these efforts are briefly summarized next.

The first Decision Skills Training program was developed in response to a request from the USMC to train squad leaders to become more effective battlefield decision makers (Klein, McCloskey, et al., 1997; McCloskey, Lake, Pliske, & Klein, 1998). The USMC wanted Decision Skills Training for their squad leaders because they were experimenting with new concepts of battlefield operations; ones in which small teams operate independently. The leaders of these teams were being faced with more decision-making responsibility than ever before. In response, the USMC needed an effective program to enhance their squad leaders' decision-making skills and provide them with opportunities to practice these skills. The training that was developed for the Marines provided the squad leaders with tools that support the strategies for achieving expertise. Thus, the squad leaders could use the techniques they learned to get the most out of their experiences, and optimize their learning, just as experts do.

To support this need, Klein, McCloskey, et al. (1997) reviewed recent work in the field of expertise (Chi, Glaser, & Farr, 1988; Ericsson & Charness, 1994; Gopher, Weil, & Bareket, 1994; Groen & Patel, 1990; Shanteau, 1988). From the literature, they identified a set of strategies that appear to be effective in enhancing skills. These include: engaging in deliberate practice, so that each opportunity for practice has a goal and evaluation criteria; compiling an extensive experience bank; obtaining feedback that is accurate, diagnostic, and reasonably timely; building mental models; and obtaining coaching. Researchers then developed methods to

help the squad leaders take advantage of those strategies. Some of the methods identified included:

1. Decision Requirements Exercise. In this exercise, the squad leaders defined the challenging decisions they were faced with on the battlefield, and identified why those decisions were challenging, the types of errors that were commonly made, and the strategies that could be used to deal with the decisions. After performing this exercise, the squad leaders had a better sense of the judgments and decisions facing them, why they were difficult, and where people can go wrong.

2. Tactical Decision Games (TDGs). A series of fifteen TDGs were developed and the immediate superiors of the squad leaders were trained to conduct TDG seminar sessions. The TDGs were tailored to the types of decision-making scenarios that the squad leaders would likely encounter on the battlefield. They focused on giving the squad leaders training on the cognitively challenging aspects of their job. The TDGs were low-fidelity, paper-and-pencil simulations of incidents that might occur in the field. Each TDG presented a dilemma, with high levels of uncertainty. Participants worked under time pressure, with only 3-5 minutes to consider how they would react. Participants were then called on to verbally issue their orders in front of the rest of the class. The seminar leader questioned the rationale behind the participants' actions, and other students were also encouraged to question the reasoning behind the orders. These TDGs were intended to provide indirect experiences, and to allow practice in rapid decision making. This training was later extended to show students how to develop their own TDGs based on the decision requirements that they had identified earlier. The TDGs that were developed for the squad leaders were typically practiced at the rate of one to two per week.

3. Uncertainty Matrix. This exercise was developed to help people reflect on their uncertainty-management practices. They considered the uncertainty that they were encountering, how they were dealing with that uncertainty, how that uncertainty was affecting their performance, and how they might better deal with it. As a result of this exercise, participants realized that they were dealing ineffectively with their uncertainties.

4. PreMortem Exercise. The idea of a PreMortem is to identify key vulnerabilities in a plan prior to execution. After someone has developed a plan, the team then spends a few minutes trying to determine where the plan is most likely to fall apart. The intent is to uncover critical flaws and areas of concern that are otherwise ignored. The PreMortem achieves this by having team members assume up front that the plan has failed. The challenge then becomes uncovering different causes for this failure. These flaws can then be dealt with up front, while the plan can still be modified.

5. Post Mortem. This tool was developed to have the squad leaders reflect on what went well and not so well during an exercise (both a TDG and an actual field training exercise), and to use this reflection to increase the learning from experience. Typically, after an exercise there would be an after action review, covering the actions taken and other actions that might have been better. The Post Mortem checklist complemented this by addressing processes. It allowed the participants to explore patterns that might have been seen earlier, and assessments that were mistaken.

To measure the effectiveness of the training program, Klein, McCloskey, et al. (1997) relied heavily on subjective evaluations. The participating squad leaders and their immediate superiors indicated that the training was useful, that performance improvements had occurred that were attributable to the training, and that they would be likely to continue to use the techniques.

Teamwork skills. Research shows that members of effective teams have accurate mental models of team processes that are shared with other team members. Cannon-Bowers, Tannenbaum, Salas, and Volpe (1995) define shared mental models as representations of how members' roles interact, the relationships among team roles, the information sources that are important, and the appropriate communication channels and patterns of information flow. They are "...preexisting knowledge structures developed over time and generalized to a variety of situations" (Cannon-Bowers et al., pp. 350-351).

The role of shared mental models in team performance is to provide a set of organized expectations for performance by which to draw accurate, timely predictions (Cannon-Bowers, Salas, & Converse, 1992; Salas & Cannon-Bowers, 1997). Some advantages of shared mental models are that they enable team members to generate expectations about their teammates' roles, the task demands, and the equipment used. Teams with these knowledge structures are more likely to have accurate expectations in regard to the team's needs and requirements. By extension, they should be able to respond to or even anticipate needs and requirements, thus resulting in more proficient team performance.

Cannon-Bowers et al. (1992) suggest that team effectiveness is a function of whether the expectations generated from team members' mental models are compatible with the expectations generated by other team members. In order to ensure compatibility, team members should share their mental models that describe interactions with one another, but not detailed models of their individual functions. However, other team members should possess familiarity with those functions. Therefore, models that define an individual's contribution to the team's task need to be common among team members. In addition, models that create expectations about how events will probably occur and how the team will possibly respond to task demands should also be shared. The authors summarize that the theory of shared mental models does not mean identical mental models, but rather compatible mental models that lead to common expectations for the task and team.

Salas, Cannon-Bowers, and Johnston (1997), Johnston, Smith-Jentsch, and Cannon-Bowers (1997), and Cannon-Bowers et al. (1992) discuss ways to develop shared mental models. Their techniques include:

- training team leaders to encourage team members to discuss their roles and expectations with other team members;
- training the team members on teamwork skills such as situational awareness, leadership, and techniques to share workload among the team;
- providing experience for teams to function under the types of stressful conditions they will encounter by cross-training (team members practice on the roles and tasks of others so they understand the responsibilities of other team members);

- incorporating feedback mechanisms, such as debriefing sessions, into training to improve accuracy of shared mental models;
- allowing team members to self-correct their performance by diagnosing their own performance deficiencies as part of a structured process that provides developmental feedback at the completion of a training session; and
- showing leaders how to maintain shared situational awareness.

Recent research on training and assessing shared mental models was reported by Stout, Cannon-Bowers, Salas, and Milanovich (1999). They explored the relationship between team planning, shared mental models, and coordinated team decision-making and performance. Results indicated that effective planning (as indicated by activities such as goal setting, sharing information, and clarifying roles and responsibilities) increased the formulation of shared mental models and resulted in improved coordinated team performance. While the research had not been reported before the training design and development work reported here, it provides consistent evidence of the role of shared mental models in teamwork.

In the literature reviewed, the consideration of roles and function is closely linked to development of shared mental models. The BCR I (Elliott et al., 1998; MMBL 1998a) examined the roles and functions that would be assumed by staff members in future operations. One of the findings was that participant roles and responsibilities for the new multifunctional positions should be identified and communicated to the participants in order for training on functions and tasks to be effectively accomplished.

Situational awareness. Developing shared mental models among staff members should lead to more accurate situational awareness. Although definitions of situational awareness vary, Endsley's (1988) is the most often cited (e.g., Fracker, 1988; Pew & Mavor, 1998; Randel, Pugh, & Reed, 1996). Endsley defines situational awareness as "...the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (p. 97). Pew and Mavor emphasize that for the military, situational awareness is the spatial awareness of static positions of self, friendly forces, and enemy forces without regard to their movements. They suggest that this view should be expanded to incorporate Endsley's concept of the dynamic nature of the battlespace. The 1997 edition of FM 101-5-1, *Operational Terms and Graphics*, addresses this concern by the use of the term "battlefield visualization." Battlefield visualization is defined as "the process whereby the commander develops a clear understanding of his current state with relation to the enemy and environment, envisions a desired end state, and then subsequently visualizes the sequence of activity that will move his force from its current state to the end state" (DA, 1997b, p. 1-18).

Situational awareness is usually studied in occupations where individuals are required to make quick decisions such as pilots, air traffic controllers, fire fighters, and military commanders (Randel et al., 1996). According to Endsley (1995), some of the important factors affecting situational awareness include stress, system complexity, and operator workload. A certain amount of stress can increase performance by increasing attention to important aspects of the situation. However, too much stress causes people to narrow their field of attention to a limited number of aspects, and to sample only dominant or probable sources of information. System complexity also negatively affects situational awareness, as does operator workload. The effect

of these factors may be moderated by the degree to which the operator has developed an appropriate internal representation of the system and how well that representation fits with that of other team members.

An aspect of situational awareness, known as crew awareness (Pew & Mavor, 1998), refers to the extent to which staff members have a shared mental model of what is occurring and knowledge of how other members are perceiving the same situation. Expectancies are important for coordinating team activities, and for enabling all team members to notice discrepancies and anomalies and thereby to notify the team that the shared situational awareness may be inaccurate. Development of crew awareness allows the staff to function in unison toward a common goal. In a recent study examining decision-making in a USMC regimental command post, the staff had problems maintaining a shared situational awareness (Klein et al., 1996). For example, situational awareness seemed to only flow in an upward direction to the commander, and subordinates rarely had an awareness of the whole picture. Therefore, the staff may have been executing courses of action without completely understanding the purpose.

Situational awareness stresses the importance of training teams to make better decisions, work better as a team, and learn like experts. Prince, Chidester, Bowers, and Cannon-Bowers (1992) have developed several team training programs for the Navy using the concepts of shared mental models and situational awareness. The use of situational awareness to focus attention on critical cues is important for team members, and one of the challenges is to find ways to selectively share information so that information overload is avoided. Expectancies are important for coordinating team activities, and for enabling all team members to notice discrepancies and anomalies and thereby to notify the team that the shared situational awareness may be inaccurate.

Klein, McCloskey, et al. (1997) have developed techniques to help teams gain experience with developing situational awareness and shared mental models. One useful technique is referred to as roles and functions definitions. This technique identifies the extent to which team members understand the task responsibilities, expertise, and roles of every other member and the extent to which they understand the resources required by the team for performing its functions (e.g., email, information sources). The inclusion of resources specifically in this dimension was influenced by the work of Fleishman and Zaccarro (1993) and Helmreich and Foushee (1993).

Another technique developed by Klein, McCloskey, et al. (1997) provides the team with insight into how the team members think. Different team members have different assessments of a situation. Even the clearest spoken or written intents cannot completely solve the problem because members of a team have unique past experiences, are operating in slightly different environments, and react to situations differently. The technique, presented as a situational awareness calibration exercise, provides insight into how team members perceive the same environment by asking team members to answer specific questions at critical points during an exercise or simulation. The type of questions in the military domain could include issues regarding expectations, important environmental cues, prediction of future events, quality of communication among team members, and indicators that a plan is either succeeding or failing. Sample questions include: what is our primary goal right now; and what will be happening 10 minutes from now. These data can then be used to evaluate how well the team is

communicating, to better understand how team members perceive their roles and functions in the bigger picture, and to generate strategies for a coherent overall team situational awareness.

Information management. Information management is an essential skill, related to shared situational awareness, that is a critical aspect of effective team performance (Serfaty & Entin, 1997). It ensures that the commander and his staff have good situational awareness based on the available information. It also enables the team to handle the flood of information caused by increasing information technologies, sensors, and communication channels. A critical aspect of information management is that the required information reaches the right person in time for it to be utilized to its maximum potential (DA, 1997a). Individuals have to know who needs what information, when they need it, and for how long it is still relevant. Thus, members of the team know each others' roles and functions and which information supports those roles and functions. In time of high stress, it also requires individuals to appropriately filter the information so that the commander, or recipient of the information, is not inundated. The use of situational awareness to focus attention on critical cues is important for team members, and one of the challenges is to find ways to selectively share information so that information overload is avoided.

Two ways of training teams in information management skills are the Team Adaptation and Coordination Training (TACT) (Serfaty & Entin, 1997), and Staff Training in Information Management (STIM) (Freeman, Cohen, Serfaty, & Thompson, 1997). These training methods emphasize the adaptation of communication and coordination strategies by team members under variable conditions of stress. They provide shared situational awareness and shared understanding of roles and functions among team members. They also provide strategies to adapt information "push and pull" to the changing nature of the task environment (e.g., due to increased time pressure or increased workload). Information push and pull refers to the passing of information from one source to another (push) and the requesting or seeking of information from different sources (pull). Research by Entin, Serfaty, and Deckert (1994) indicates that team effectiveness is enhanced when one or more team members provide information *before* they are requested to do so (push). Furthermore, providing information in advance appears to be particularly beneficial in situations characterized by increased workload.

Team members are given alternate strategies to deal with the push and pull. They are also trained to recognize when situational demands are changing and therefore require an adaptive information management strategy. One method is for the team leader to provide regular situation updates so that team members know the current situation and what they are trying to accomplish. Another method is to provide either cross training or explicitly state each member's role, primary tasks, and key information requirements. This method for training team information management has been demonstrated successfully for Navy Anti-Air Warfare teams in the CIC (Serfaty & Entin, 1997).

Training Structures

The second major aspect of training that would impact the design and development was considerations of training structure, that is, *how* to train. Based on their research, Klein et al. (1996) feel that when new digital systems are used on the battlefield, they are often not used to

their full potential. They attribute this to lack of proper training of the operators on the equipment. Proper training is defined as not only the content of the training (training the right topics), but also organization and presentation of the training.

Research in cognitive psychology indicates that experts differ from novices not just in the amount they know, but in the way their knowledge is organized (Means, Salas, Crandall, & Jacobs, 1993). Experts group information and use their domain knowledge base to organize and structure new information; they even perceive displays differently compared to novices. An extension of this finding is that people should be taught not only how to *think* like experts, but also how to *learn* like experts.

This structuring of knowledge by experts, and the effects on perceiving and learning new material, has been demonstrated in several diverse fields, such as chess (Chase & Simon, 1973), physics (Chi, Feltovich, & Glaser, 1981), statistics (Schoenfeld & Herrmann, 1982), computer programming (Adelson, 1981), and baseball (Chiesi, Spilich, & Voss, 1979). The differences between experts and novices in organizing knowledge has implications for training, including the training of military decision-making in operational settings.

After reviewing the literature on training structure, four aspects of effective training were identified that were particularly relevant to the proposed training development: use of advance organizing techniques, part-task training, deliberate practice, and context relevance. The supporting literature is summarized briefly below.

<u>Advance organizers</u>. When experts learn, they organize the new material by reference to known concepts and prior knowledge. Smith, Ford, and Kozlowski (1997) refer to this type of knowledge organization as an advance organizer. Not only is it a tool that experts have developed for themselves, it is a tool that can be given to non-experts. Before actual training even begins, an outline or overview of the new material can serve as an advance organizer. Advance organizers provide an initial organizing structure that allows trainees to organize and retain the material to be learned. They are usually based on relevant concepts that are already in the trainee's cognitive structure and these concepts are used as part of the organizing framework. Cannon-Bowers, Rhodenizer, Salas, and Bowers (1998) define advance organizers as "...a category of activities such as outlines, text, aural descriptions, diagrams, and graphic organizers that provide the trainee with a structure for the information that will be provided in the practice environment" (p. 298).

An example of an advance organizer is provided by Cannon-Bowers et al. (1998). When training employees to use a complex software package, advance organizers could be used to display the organization of material hierarchically (to correspond to pull-down menus) so the learners could follow it as they learn the software. As they practice using the program, they will have prior knowledge that the functions are hierarchically related. This should help the learners develop appropriate knowledge structures and consequently improve future performance.

According to West, Farmer, and Wolff (1991), the concept of an advance organizer is based on the premise that two of the most important variables in teaching are what the learner already knows and how that information is organized. Presented prior to the new material, the

advance organizer serves as a bridge, or transition statement, providing a brief outline of the new material. The advance organizer helps learners recall what they know about a topic, particularly their cognitive framework for the information, and transfer that knowledge, or framework, to new topics. Without such an understanding of the connections, learning might be limited to rote memorization and quickly lost.

Advance organizers seem to be more effective when the learner is unfamiliar with the material, is inexperienced, or is expected to transfer the information to new situations (Mayer, 1981). West et al. (1991) suggest that the strength of using the advance organizers is that they facilitate long-term recall and transfer of general concepts. The effects increase over time, and when the instruction lasts several days rather than a few hours, the retention effects are stronger. In a study conducted by Kraiger, Salas, and Cannon-Bowers (1995), participants were provided with an advance organizer either before or after completion of a training session on a tactical decision-making simulation. Results showed that the quality of the participants' knowledge structures correlated with performance after training for those who received the advance organizer information prior to training, but not for the others.

The organization of the advance organizer is, of course, critical. Cannon-Bowers et al. (1992) suggest that presenting learners with an advance organizer and presenting training in a hierarchical organization will lead learners to acquire the intended organizational structure of the material. Elliott et al. (1998) recommended that the BCR training include presentation of a flowchart of responsibilities for nodes and among nodes, as a way of organizing and clarifying the information being presented. Other recommendations were to brief the purpose of the BCR and its goals to all participants, to include a general overview, and to describe primary and secondary responsibilities for each position. All of these were suggested as ways of assisting the training audience to more quickly grasp what they were to do.

Part-task training. Another aspect of training that impacts performance is whether the task is trained in parts or as a complete whole. In part-task training, parts of the task are presented separately, and the learner practices each subtask in isolation before receiving the whole task. Mané, Adams, and Donchin (1989) examined participants' performance on a computer game after receiving part- or whole-task training. The participants who received part-task training performed better and required less training time than the others. Those who received whole-task training required twice the amount of training time.

On the other hand, Stammers (1982) points out that in a complex task, there is a danger in breaking the task up artificially. The danger is that the learner may learn to perform the subtask one way in training, only to find that the nature and demands of performance change entirely when the rest of the subtasks are added and performed as a whole. Therefore, care should be taken to develop training that avoids this potential problem by not teaching everything in isolation, but rather adding context and requiring some parallel performance.

A similar concept is what Means et al. (1993) refer to as scaffolding, which reduces cognitive workload in the early stages of training. In this method, the instructor or training system initially handles some portions of the task so that the trainee can focus on the more critical aspects. As the trainee acquires competence, the workload gradually increases to realistic

levels. For example, early training might not require the trainee to consider logistics, but would require it in later training.

For both the part-task training and the scaffolding variant, the implication is that simple parts of tasks would be taught first, in simple sets. These would be gradually brought together into more complete sets, and more complex elements would be added, until the learner is practicing the whole task as an integrated activity. In previous BCRs (Elliott et al., 1998; Elliott, 1998), training was conducted by teaching each function of the digital system in isolation. Learners were taught the purpose of the buttons in the order they appeared on the screen, rather than in a hierarchical structure. This was an extreme form of part-task training, and artificially segmented the task. It did not provide learners with a basic structure on which they could build their training. Elliott et al. made several recommendations on the basis of the BCR results, including training beyond "switchology" to include how to use the tools, information gained by using the tools, and their effect on visualizing the battlefield.

Deliberate practice. In addition to structuring training from simple parts to more complex whole tasks, deliberate practice is also very important. Deliberate practice refers to more than just practice. It incorporates the concept of part-task training described above, in that the task is broken down into smaller tasks increasing in difficulty. In addition to simply practicing the task, the learner receives guidance and feedback, and repeats the task until the criterion is achieved. Frederiksen and White (1989) point out that unguided practice is no more effective than no practice at all.

A related concept is structured training (Campbell, Campbell, Sanders, Flynn, & Myers, 1995). Structured training combines the identification of training objectives with deliberate construction of scenarios or simulations to cue performance of the objective tasks. For entry level training, the scenarios may be very highly structured, so that all users encounter the same sequence of events at the same level of difficulty. For more proficient trainees, scenarios and training guidelines allow for more flexibility in how the events are presented, how quickly things happen, how powerful the enemy is, and so on. In either case, structured training provides for a focus on critical tasks in a planned sequence of performance that reinforces learning and builds on prior experience. The value of the training is enhanced when observers are on hand to mentor and coach the participants, and when the observers are aided by guides to the critical performance elements.

Practice, whether deliberate or not, is critical. Ericsson, Krampe, and Tesch-Römer (1993) discuss the importance of practice in gaining expertise. According to the authors, practice is the single most important determinant of performance: the more practice the better, since skills grow best incrementally. Solid learning takes time and requires a steady progression of slowly increasing effort over the course of considerable deliberate practice. In an experiment conducted by Jones (1989), participants practiced video games over a period of 15 days and were tested 4 to 18 months later. Based on his findings, Jones concluded that when participants are given a generous amount of time for practice and do, in fact, practice during that time, all participants learn and retain their skills better than those with less practice time.

Means et al. (1993) describe several aspects of training that can produce the expert-level decision-making skills that combat commanders need. One of those ideas is training to achieve automatic rather than controlled processes. Controlled processing is slow and requires cognitive resources whereas automatic processing is rapid and can continue without conscious attention; thus, it can be accomplished in parallel with other activities without degrading performance. Such training requires very large amounts of practice. In the context of decision-making, the goal is not to train the decision-making, per se, but to train the other task components to automaticity. The commander can then make decisions without having to concentrate on all the underlying skills. In the research described above, Jones (1989) found that individuals who learn rapidly will overpractice, and this leads to the tasks being performed automatically. This is an important advantage for decision-making in combat since combat decisions involve complex tasks, multiple goals, and uncertain environments, all of which produce a heavy workload.

During the second BCR, participants pointed out that they felt the need for structured training with more practical exercises requiring the use of all the digital tools and more hands-on training with the tools (Elliott, 1998). These suggestions tie closely to the notion of part-task training as well as deliberate practice.

Context-based training. Finally, although all of the previously mentioned techniques are important for performance improvement, their influence will be even stronger if training is provided in a job-related context. According to Means et al. (1993), training should be conducted "...within a meaningful (but not necessarily whole) task context..." (p. 316). Salisbury (1990) suggests that people are better at remembering meaningful information; therefore, the goal of training should not be to make learners memorize information. Rather, training should attempt to modify tasks which do not have much intrinsic meaning into more meaningful concepts. Finally, Cannon-Bowers and Bell (1997) propose that embedded training (i.e., training in the operating environment so that training takes place on the job) is one of the necessary types of training in order to produce effective decision-makers.

Cannon-Bowers et al. (1992) suggest that allowing learners to practice interacting with a system without any guidance or context will *not* lead to the development of an acceptable understanding of the material. Specific instructional guidance should be provided, and the training should be specific to the job context, to ensure accurate understanding among team members.

Training and Performance Evaluation Methods

As techniques for training digital staffs evolve from training programs for analog staffs, there is impetus to exploit the inherent capabilities of the hardware and software the information-age staff is using to measure its level of proficiency and to provide feedback on its performance (Dwyer, Fowlkes, Oser, Salas, & Lane, 1997). The feedback issue arises out of the performance training literature discussed in the previous section. A recurring theme in the documentation of training research is the need for feedback. Within the NDM framework, research on the learning styles and knowledge structures of experts suggests that feedback, which helps the learner to analyze and categorize an experience, will result in more long-lasting performance improvement (Chi et al., 1988; Shanteau, 1988).

A review of the training literature identified the "...lack of team performance measures as a hindrance to the development of effective team training systems" (Dwyer et al., 1997, p.139). McIntyre and Salas (1995), in reporting their research on measuring and managing team performance, identified issues not only in determining what training interventions could be developed to enhance team performance, but also a bigger issue of determining if the training interventions worked. Dwyer et al. described the measurement of actual team performance as important but noted that it was done less frequently when assessing team training. They also described the typical evaluation of training as including reactions to the training, teamwork attitudes, and knowledge of key teamwork concepts.

Other researchers involved in measuring team performance (e.g., Cannon-Bowers & Salas, 1997) note that both processes and outcomes must be addressed. Process measures address the activities, responses, and behaviors that people use to accomplish tasks. They include planning, decision-making, information processing, and synchronization. The processes need to be linked to outcomes such as execution activities and combat effects for interpretation. Outcome measures are usually not diagnostic by themselves since they do not show the underlying causes of performance, or how to improve it. Thus, it is necessary to collect both process and outcome measures and find a way to relate them to each other. Another consideration in designing measures relates to levels of measurement. Cannon-Bowers and Salas point to the use of multiple levels as particularly important in team performance measurement. For example, assessing individual communication skill is important for feedback purposes, but communication skills should also be assessed at the team level because of the implications for staff processes and products.

In an attempt to overcome deficiencies they perceived in the traditional method of evaluating team performance which relied on SMEs' numerical ratings of performance, Dwyer et al. (1997) developed the Target Accepted Responses to Generated Events or Tasks (TARGETs). By identifying or embedding events in training exercises that would provide opportunities to observe behaviors of interest, the number of observations could be controlled, observation instruments specific to the event could be developed, and assessor biases could be reduced by creating checklists that reduce the rating of a behavior to yes, it was performed, or no, it was not performed.

When TARGETs was implemented in a training environment where the participants were geographically dispersed, several lessons were learned which may apply to designing measurement systems for assessing a digital staff's training performance. Assessors need to have and maintain access to the trainees' communications nets. A backup system to provide feedback on an event that an assessor may have missed because of communication difficulties or other unforeseen circumstances is essential. Converting assessments from multiple sources and formats into a single feedback format is time consuming and might detract from the requirement to provide timely feedback to the trainees. Spontaneous events might not fit into the checklists or other instruments designed to record behavior which might mean that creative or unanticipated behaviors may go unreported. Another lesson reported was that one of strengths of TARGETs (structuring the observation checklists into answering yes or no questions as one means of reducing assessor bias) does not reflect the degree to which a behavior may have been performed in terms of accuracy, completeness, timeliness, and so forth. A proposed solution for

this shortcoming was to incorporate observer qualitative comments into the checklists for behaviors that had room for improvement even though they had been performed by the trainees (Dwyer et al., 1997).

The TACT training, previously mentioned, was designed to look at how teams adapt their decision-making strategies and how team training interventions and structural reconfigurations can best contribute to the team's ability to maintain superior performance under a wide range of stressful operational conditions (Entin et al., 1994). Using trained observers, the researchers measured six dimensions of teamwork: team orientation, communications behavior, monitoring behavior, feedback behavior, back-up behavior, and coordination behavior. At the conclusion of a test of the TACT team training procedure, teams that were rated higher in teamwork behaviors performed better after their team training than control teams which had not received the training. The implication of this research is that measuring teamwork behaviors may help quantify team performance. Another dimension of teamwork measured by the research team was the communication data generated during the research. The researchers measured the total amount, direction, type, and content of the communication. In general, Entin et al. found that measures of communications could predict the success of team training interventions, but that this measure required considerable analysis to obtain results.

Pioneering research in the early 1970's on battalion command and control demonstrated there was a measurable relationship between staff competence and combat effectiveness (Crumley, 1989). Crumley notes that in measuring staff competence, there have been two dissimilar approaches. One approach is that if the unit accomplished the mission then the staff process was effective. The second approach is that due to a multitude of factors external to the staff, such as opposing force (OPFOR) activity, inappropriate application of doctrine, or deficient training, the quality of the staff process is a better measure of staff effectiveness. On the other hand, Olmstead (1992) favors process over outcome in terms of defining success. "Where effectiveness is the ultimate outcome (mission accomplishment, achievement of objectives, productivity, etc.), competence is the capability of the organization to perform the critical functions (processes) that lead to achievement of effectiveness" (Olmstead, 1992, p. X-5).

Three methods of performance measurement used in previous training research are: trainer observers or assessors collecting critical information on both processes and outcomes, surveys, and interviews (e.g., Campbell, Deter, et al.,1999; Koger et al., 1998). Together, these methods can yield a multifaceted look at team processes during training. A fourth approach, less widely used, involves automated measures.

Automated measures use the digital information being exchanged among various C^4I systems and nodes to provide process, product, and outcome information. For example, previous ARI research (e.g., Lickteig and Emery, 1994) demonstrated the utility of developing automated measures that defined information acquisition and communications. The measures were message content, message source, time message received, time message opened, action taken (relay, delete, no action), time action taken, and direction message relayed. Thus, for example, they were able to analyze message processing speed by using message opening time, read time, relay time, and delete time.

The use of automated measures was furthered during the Combat Vehicle Command and Control (CVCC) Evaluation conducted by ARI at Fort Knox (Lickteig & Collins, 1995). The objective of the effort was to determine the effect of vertically integrating digital command and control systems in an armor battalion. To assist in this evaluation, a total of 64 automated measures were developed. These measures were based on the tactical battlefield operating systems functions of maneuver, fire support, command and control, and intelligence. The analysis of the data produced by these measures formed the basis for the evaluation. Several limitations were noted in using automated measures in this evaluation. Among them were the need for additional automated routines to detect misorientation and boundary violations, more precise indictors of target acquisition, and identification of the sources for all OPFOR kills. In short, automated measurement in digital systems can provide a wealth of detailed information about activities performed on the systems, but the challenge is to make sense of the details.

Conclusions

The review of the literature on training content, training structures, and measurement methods led to specific recommendations concerning training for future staffs. The training outline (described later in this report) incorporates elements of an advance organizer around which to structure learning; implements part-task training presented within a meaningful context; and provides learners the opportunity for guided practice and feedback. By using these concepts in conjunction with structured training (for a review, see Campbell, Deter, & Quinkert, 1997), staff members can gain a better understanding of why they are doing what they are doing as well as how to use the system in an operational context.

On the content of training for staffs in digital environments, the literature indicates that decision-making skills can be improved with training that focuses on pre-action analysis, examination of uncertainties and weaknesses in a plan, and post-action discussion and reinforcement of lessons learned. Team orientation can be enhanced by training focused on understanding roles and functions, maintaining situational awareness, and attending to information flow management. The training design discussed in this report includes elements designed to address both decision-making skills training and team orientation.

Review of the literature on measurement led to the recommendation of a multifaceted approach to address two measurement needs: assessing training quality and providing staff performance feedback. The measurement approach described in this report addresses both individual and team process and outcome results.

Prototype Training and Evaluation Methods

The design for the training of future staffs is described here in terms of four aspects, all based on previous research. Three of those aspects were developed on the basis of the literature reviewed above: training content, structure, and assessment. The fourth – the design and development methodology – is derived from the published ARI methodologies for development of structured training described previously. Although the design is general enough to be used for future staff training under a range of conditions, there are four underlying assumptions.

First, staffs are already moderately proficient in their individual skills and familiar with basic staff operations. They need not be highly experienced, nor is it necessary that they have worked together as a staff for any great length of time.

Second, training participants are not yet familiar with certain key elements of their environment. Whether they are training up for a new type of staff organization, a new command post setup, or new digital capabilities, the training will assist them to both learn the novel elements and also become more proficient as a staff.

Third, they are operating in an information-rich environment. The training design is specifically aimed at operating environments wherein staff members deal with complex information management and communication issues. This assumption is not a necessary one; the procedures and techniques should also be useful in conventional (analog) environments.

Fourth, some type of virtual or constructive simulation will be used. This also is not a necessary assumption. Although the use of simulation greatly aids in providing realistic contexts and automated measurements, the training design can be used in live simulation settings as well.

Training Content for Training of Future Staffs

The content of the training for future staffs should cover three training needs: system operations, tactical skills using the capabilities of the new environment, and team process skills to bring the staff quickly to a high level of proficiency. The system operations training is primarily individual training. Each staff member needs to know how his or her job responsibilities are performed using the digital equipment. This will include not only basic instruction on button-pushing and system capabilities, but some training in techniques and procedures for using the system efficiently.

The tactical skills training is more advanced than system operations. It requires that staff members, after becoming individually proficient with the C^4I system, work in small groups to use their new capabilities to perform small parts of their jobs. The training would gradually build up to having the full staff performing in an integrated and self-directed way, responding to job situational cues and actually performing the appropriate actions.

The team process skills training should include specific information, practice, and feedback addressing the four content areas described earlier: decision-making, situational awareness, teamwork skills, and information management. These need not be treated as separate topics, any more than they can be separated during performance. They should also not be separated from the job situation, as generic skills, but rather should be practiced and discussed as an integral part of the mission planning, preparation, and execution cycle.

Training Structure for Training of Future Staffs

The recommended structure of the training incorporates aspects described earlier: advance organizing principles, part-task training, deliberate practice, and context-based training. The structure described here and eventually used in the prototype training package is very similar to that of the structured simulation-based training that ARI has been developing since 1993

(Campbell, Deter et al., 1999; Campbell, Graves, Deter, & Quinkert, 1998; Campbell, Pratt et al., 1999; Flynn, Campbell, Myers, & Burnside, 1998; Hoffman, Graves, Koger, Flynn, & Sever, 1995).

The initial information presentations to the participants should include multiple instances of advance organizers. For whatever is novel within the future environment, the training audience should be specifically instructed on its relation to the "old" way of doing business, and told why the change has been made. If there are elements of the new environment that are unchanged, these should also be pointed out to the training audience. Job aids that graphically show the old, the new, and the linkage should be used where possible.

Incorporating principles of part-task training means that the system training, tactical skills training, and team process skills training will each be broken down into smaller chunks. Training participants will receive training on small segments of tasks and may even be clustered into small groups to receive specific system training. As the training proceeds, the task segments will be aggregated and the small groups brought together to allow fully integrated practice of tasks and activities.

As the part-task training occurs, there should be numerous planned opportunities for deliberate practice of the skills just taught. This practice time should be structured to focus on the skills and integration of previously taught skills, and should focus on training to criterion. That is, not only should ample time be provided, but participants should demonstrate their grasp of the skills several times (thus minimizing lucky guesses and allowing for overpractice) before moving on to the next segment. Feedback is a necessary component of deliberate practice; participants should not have to decide for themselves whether or not they have achieved proficiency.

Finally, all of the training, from the basic and advanced system training to fully integrated full staff exercises, should be presented in the context of realistic job requirements. This can be accomplished even for the simplest task segments in the system training, by telling or showing the participants how the skill will be used as they perform their jobs. The complex integrated exercises that come toward the end of training can initially have simple scenarios, with later exercises stressing the participants with very high-intensity scenarios (e.g., less time, more enemy, conflicting information, degraded conditions).

Training and Performance Evaluation of Future Staffs

In order to evaluate training and performance for future staffs, a combination of automated measures, surveys, observations, and interviews should be used. Specifications for the evaluation plan would begin with an analysis of the specific staff task, process, or product to be measured and a determination made as to the method or methods that could best be used to evaluate each task, process, or product. The measures would then be designed and developed to provide converging and efficient coverage of staff performance issues. Devices such as laptop computers or personal data assistants should be incorporated for reducing the burden of observation and survey data collection, analysis, and formatting so that immediate training feedback could be provided to the staff.

Methodology for Design and Development of Future Staff Training

The development of structured training for a future staff should follow the Army's systems approach to training (DA, 1999) and the procedures outlined in Campbell and Deter (1997). The development process should begin with a thorough front-end analysis of what is known and what needs to be learned about the training needs, training conditions, and training audience. To the extent possible, all training requirements and resources should be documented (or at least noted as information needs), and consensus on them obtained from those who have responsibility for the training and performance of the training audience.

Analysis then leads into design and development, resulting in products that should be appropriate for the conditions imposed by the environment and that should satisfy the training requirement. The design and development work incorporates the training content and structure decisions described above, and includes provisions to measurement for feedback and program evaluation.

Throughout the analysis, design, and development activities, training products should be under constant review and revised as necessary. During initial implementation, formative evaluation of the training products and process should be conducted to assess success in meeting the training requirements. Evaluation should continue for additional implementations of the training, so that developers can track performance deficiencies that should be included in the training and training deficiencies that should be corrected.

Training Analysis

As stated above, training design and development relies on a thorough front-end analysis (Campbell & Deter, 1997; DA, 1999). Such analysis includes examination of the training audience, their job requirements, and a complete delineation of the job conditions that will be represented in the training. As a starting point for this analysis, the project team used the MMBL's future battalion battle staff concept which had been the focus of recent experimentation at Fort Knox. This future battalion battle staff is led by a commander, assisted by 13 principal staff officers and non-commissioned officers, which are deployed in four command and control vehicles (nodes) and operate advanced C^4I systems. The MMBL has used an enhanced Modular Semi-Automated Forces (ModSAF) system to emulate advanced C^4I systems. These systems are referred to collectively as the surrogate command, control, communications, and computers (SC^4) system. While there was no published operational or procedural doctrine for this staff, the project team was given access to previous reports on the MMBL's experimentation which provided a starting point.

The analysis process underlying design of the prototype training package included:

- defining the battalion staff processes in terms of responsibilities for nodes and for individuals within nodes;
- defining how the battalion staff processes should (or could) be performed within the nodes;
- defining what the SC^4 tools are and what they can do; and
- defining individual functions and tasks using the SC^4 tools.

These processes were not completely sequential. Some were parallel activities, and every product underwent continual modifications to ensure that it remained consistent with respect to other products. If there had been no previous documentation concerning the tools, tasks, and roles, it is likely that the process would have proceeded in a very different order. However, the discussion of the analysis process below is presented in the order that represents how the work generally proceeded and also shows most clearly the developmental and conceptual linkages. Products for each of these analysis components are contained in Training and Measurement Support Package Volume 1 (1999) and examples of the materials can be seen in Appendix B.

Descriptions of the node and individual job responsibilities were derived from an integration of results from the BCR II (Elliott, 1998), subject matter expertise on Army operations at battalion level, and doctrinal materials such as FM 101-5 (DA, 1997a). The subject matter expertise and doctrinal reference were used to define the staff process objectives, which are essentially unchanged from current requirements. That is, the staff is still responsible for planning, maneuvering, monitoring enemy activity, supplying the force, and so on. However, the reengineered staff environment does change the way in which those things are done and who is responsible for doing them.

Examination of BCR II results and discussions with individuals who were involved in BCR II led to a set of very brief descriptions of the roles and responsibilities of each of the four primary nodes and of the individuals within the nodes. The descriptions were also reviewed by MMBL subject matter experts. The purpose of these descriptions was twofold: to provide the starting point for more detailed performance analyses, and to provide guidance to the participating unit as they started training on how their nodes and positions were assumed to function.

In order to develop staff training objectives, the node responsibility and individual job responsibility descriptions were expanded using documentation from BCR II, along with reference to current military doctrine. The expanded descriptions took the form of performance analysis worksheets that showed what each individual in the four primary nodes would need to be doing during the planning and execution phases of a mission. The performance analysis did not attempt to account for all of the staff input and outputs during the MDMP. The analysis did account for the capabilities of the SC^4 system to display information that the staff would normally have to collect, analyze, and distribute, and concentrated on those aspects of mission planning that would be different for a future staff, geographically dispersed and equipped with an advanced C^{4}I system. The two aspects of the MDMP that were judged to be most different for this staff were: course of action development, analysis (to include wargaming), comparison, and selection; and rehearsals. The ability to issue fragmentary orders in response to rapidly changing battlefield conditions and to higher headquarters' directed changes to the unit's mission was also thought to be an important future staff attribute. This analysis was then used as the basis for outlining staff training for four segments of a unit's mission cycle which were designated as course of action (COA) development (later, mission analysis), rehearsal, battalion branch, and brigade sequel.

The performance analysis worksheets initially contained only the events within the four segments with indications of staff activities that would be triggered by each event or by activity

within the staff. After the analysis of the SC^4 tools and task functions (the descriptions, crosswalks, and comparisons described in the following paragraphs) was completed, information on which tools would likely be used in which activities was added. The performance analysis worksheets were reviewed by the MMBL staff before being used for exercise construction. The performance analysis information was also used to derive a listing of more general functions that underlie task and activity performance.

In order to provide recommendations concerning the SC^4 training, a complete and accurate listing of the tools and their use was needed. The SC^4 tool descriptions and their utilization were initially drawn from the *Battle Command Reengineering II User's Manual* (III (MMBL, 1998c). The descriptions were later revised as the system underwent upgrades. The final descriptions were reviewed by MMBL staff, and were also verified by project staff working on the SC^4 equipment. Because the *Battle Command Reengineering III User's Manual* (Mounted Maneuver Battlespace Lab, 1999a) was undergoing modifications in parallel with changes to the SC^4 system itself, the use of the manual as a source of information was limited. Therefore, project staff worked closely with the system programmers to ensure that the most current configuration and operation were represented in the training design work. Once the SC^4 tools descriptions were completed, they were used to determine how the tools should be used to accomplish the general task functions defined in the earlier performance analysis.

The general function descriptions allowed the determination of the functional training that should be provided for the training audience. The function descriptions were then crosswalked to tools, and also crosswalked to individuals within the four primary nodes. All of the definitions and crosswalks were reviewed by MMBL staff, and the functions descriptions and crosswalk to tools were verified on the SC^4 equipment. The crosswalks were used to group SC^4 tools for purposes of initial training and to identify logical groupings of training participants who should receive training on particular functions and tools. Finally, a summary of the SC^4 tools by training level was created to ensure all tools were identified and would receive adequate training.

In addition to the analysis of performance of the primary training audience, the responsibilities for the extended training audience were also examined. Close examination of BCR II operations and BCR III plans showed the responsibilities and tasks to be the same as documented in current doctrine.

Training Design

The analysis served as the foundation for design of the training that focused on staff performance. The literature indicated that staff performance could be improved with training that incorporates NDM, provides tools to increase the shared understanding of the battlefield, and allows for the practice of new skills. This type of training is most effective when presented in a scenario-based context.

The staff training was designed to focus on collective decision-making skills and team orientation within a scenario context. Early in the analysis process (previously described), however, it became evident that much of the success of the collective training would be dependent upon the level of proficiency the unit members would have with the SC^4 system. To

incorporate aspects such as part-task training, structured training, and deliberate practice, design recommendations for the initial SC^4 systems training were prepared. These recommendations covered the full train-up process from initial orientation through individual and small group training to participation in the structured collective training exercises.

The design was hierarchical, outlining a 5-level training sequence (see Figure 1). It assumed that participants would have some experience working together as a team. The training would proceed through orientation, individual training, small group training, and a series of tactical decision-making exercises (TDXs). The purpose of each level is described below.

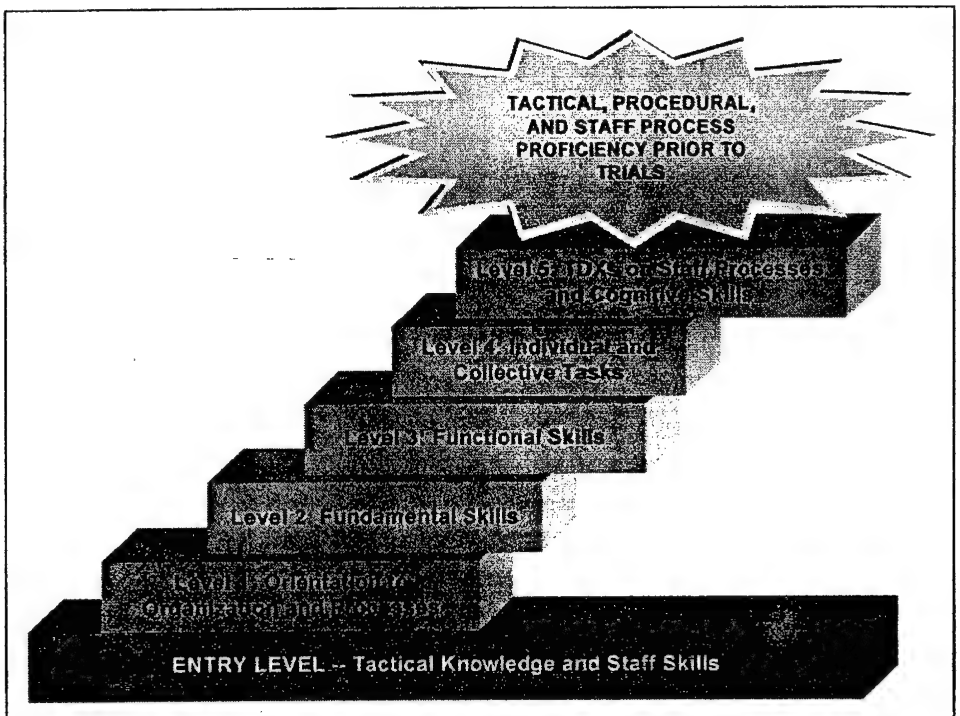

Figure 1. Training level sequence.

In Level 1, the training participants began with an introduction and orientation to the train-up and the trials. The Level 1 session was designed to serve as an advance organizer, in accordance with research indicating that learners do better if they are told what they will be learning, how they will receive it, and how it relates to current knowledge and processes. In this case, the unit was to be provided with general information regarding the training facility, the train-up, the data collection, and the activities following training. This orientation was designed to be delivered either as part of the advance visit to the unit approximately one month before the training was to start, or as part of the initial session when the unit arrived at the training site. The session was estimated to require a total of 1-2 hours.

The fundamentals training, Level 2, was designed to provide SC^4 equipment familiarity combined with general system operations. At this stage of training, the information was basic and focused on the individual with a limited context (e.g., windows manipulation, operating communications equipment). It was to be conducted with the training audience in their primary seat locations within the nodes. A research assistant (RA) was assigned to each node and was

responsible for delivering the training. Level 2 training was estimated at about 2-3 hours, so that individuals could quickly move beyond switchology to learning job-related functions.

The Level 3 training was then designed to provide the context-based training by grouping the system tools into functional groups (e.g., create overlays, conduct a whiteboard teleconference). The groupings for the Level 3 training recommendations were a result of the analysis of the SC^4 tools and task functions analysis discussed in the previous section. Though this training still focused primarily on the individual, it grouped together individuals from different nodes who performed similar tasks. In addition to learning the system, this arrangement provided unit members the opportunity to discuss how they planned to use the system in the context of their jobs in the different nodes. Level 3 training was expected to be lengthy, requiring 4-6 hours. In order to provide deliberate practice opportunities, Levels 2 and 3 training included structured practice exercises that tracked directly to the material covered in the training and could serve as checks on whether the staff had acquired the skills taught.

The Level 4 training was to be a series of small group structured exercises that provided the first opportunity to practice the new skills in a brief scenario-based context. It was designed and developed to provide the transition from system training to staff process training. The focus of the Level 4 exercises was carried another step beyond the Level 3 training, by prompting the unit members to think about how they were to work together within their node. No new system tools or functions were introduced during this training. The exercises were structured so that each node would train independently on the same collective function. This structure allowed the unit members to further explore and understand their roles and functions within each node, free of outside distractions. It also reinforced the multi-functionality aspect required to operate in the future battalion staff structure. These exercises were to prepare the unit members to participate in the Level 5 TDXs, which focused on collective training. Level 4 training was expected to run 3-4 hours. Also, during the Level 4 training, the first team training sessions were to be conducted, introducing the staff members to some considerations of information flow and their roles and functions. The team training sessions were adapted from the staff process training sessions, which are a part of the decision-skills training (Klein et al., 1996) described earlier.

Finally, Level 5 training consisted of the four TDXs and the embedded team training sessions. The TDXs brought together all training participants (i.e., primary training audience, White Cell staff, company commanders, scouts) to conduct collective structured exercises using the full capabilities of the SC^4 system. The exercises provided the opportunity to practice new skills in a tactical scenario similar to the type of mission used during the pilot and trials. These exercises not only allowed practice on the system, but provided the context for introduction of tools based on the NDM model and team process research.

Design of the TDXs was based on the performance analysis of the full BCR II mission flow described earlier, from planning and preparation through execution and sustainment activities. This analysis led to the delineation of four distinct segments that, together, required the participants to practice a wide range of staff processes and SC^4 functions. The four segments that were outlined are: a) mission analysis with wargaming; b) mission rehearsal; c) execution of a squadron branch; and d) execution of a brigade sequel.

Table 1 links training aspects discussed in the literature review that were adopted for inclusion into the various training levels in the prototype training package. In addition, the sources from which the training aspects were derived are included.

Table 1

Theoretical Training Aspects Linked to Prototype Training Package Levels

Training Level	Training Aspect	Sample Theoretical Sources
1	Advance Organizer	Cannon-Bowers et al., 1992 Cannon-Bowers et al., 1998 Kraiger et al., 1995 Smith et al., 1997 West et al., 1991
2, 3, 4	Part-Task Training	Mané et al., 1989 Means et al., 1993 Stammers, 1982
2, 3, 4, 5	Deliberate Practice	Ericsson et al., 1993 Frederiksen & White, 1989 Jones, 1989 Means et al., 1993
3, 4, 5	Context-Based Training	Bowers & Bell, 1997 Cannon-Bowers et al., 1992 Means et al., 1993 Salisbury, 1990
4, 5	Decision-Making	Baron & Brown, 1991 Fallesen et al., 1996 Klein et al., 1993 Klein, McCloskey, et al., 1997 Zsambok, 1997
4, 5	Teamwork Skills	Cannon-Bowers et al., 1995 Salas & Cannon-Bowers, 1997 Salas et al., 1997 Stout et al., 1999
4, 5	Situational Awareness	Endsley, 1988 Endsley, 1995 Klein et al., 1996 Prince et al., 1992
4, 5	Information Management	Entin et al., 1994 Freeman et al., 1997 Serfaty & Entin, 1997

Note. Training Levels: 1 = Orientation to organization and processes; 2 = Fundamental skills; 3 = Functional skills; 4 = Individual and collective tasks; 5 = TDXs on staff processes and cognitive skills.

Team training sessions were also included as an integral part of the TDXs. These sessions were designed to help the staff to focus on their roles and functions within and across nodes, their shared situational awareness, a shared understanding of the commander's intent and their plan for accomplishing it, and their intensive review of their own processes through the mission segment. With the team training sessions, it was estimated that the TDXs would require 2-3 days.

As described earlier, the period of time provided for "train up" was five days. Figure 2 shows the planned training sequence for the Level 1 through Level 5 training. As indicated in the figure, Level 2 and 3 training focused on the individual, Level 4 progressed to a small group (node) focus, and the Level 5 TDXs and team training sessions brought all elements together for collective training.

Day 1	Day 2	Day 3	Day 4	Day 5
Level 1, Initial Orientation	Level 3, Functions Training (Cont.)	Level 5, TDX 1, Mission Analysis and Wargaming	Level 5, TDX 2, Rehearsal	Level 5, TDX 4, Squadron Sequel
Level 2, Fundamentals Training	Level 4, Task Training and Practice		Level 5, TDX 3, Squadron Branch	Commander's Time
Level 3, Functions Training				

Note. =Individual training =Small group training =Collective training

Figure 2. Planned staff training schedule.

Training Development

All of the materials and information associated with the recommendations for Level 1 through Level 4 are contained in Training and Measurement Support Package Volume 2 (1999) and examples of the materials can be seen in Appendix C. It is important to note that, for Levels 1-3, these were detailed recommendations with sample practice exercises rather than fully-developed training products. They were intended to be used as templates for further development. Levels 4-5 material included completed training products.

The primary focus of the Level 1 training was to orient the training audience to what to expect over the next three weeks. The recommendations included draft slides for the information briefing that would be delivered by the Training Director. The information contained in the draft briefing slides covered:

- Purpose and Background
- Data Collection
- Training Site Conditions
- Training Expectation
- Training Schedule

Within the briefing, the new information presented during training was linked to familiar procedures. This included a comparison of the unique future battle staff features to current analog procedures and topics such as staff structure, equipment, planning processes, and METT-TC.

The Level 2 and Level 3 training package was directed at the primary system trainers, the RAs. The materials included training objectives, guidance on how the training should be conducted, and training plan outlines. These outlines were step-by-step listings of the information being presented to the unit members, with special notes to the RAs concerning information to include in the delivery of the training. The instructions indicated whether a particular tool or information had been previously introduced so that its relevance to a functional topic could be reinforced before proceeding with the new information on that topic. Each outline prescribed a sequence for the training content, although they did not detail all of the steps in SC^4 system operation. By completing this outline, future staff trainers could convert the training plan outlines to full training plans.

To address the issue of providing sufficient practice using the newly acquired SC^4 system skills, structured practice exercises were also recommended. These exercises consisted of a series of statements, or cues, to prompt specific actions from the training audience. Each structured practice exercise covered a 30-minute segment of the training plan outline content, and matched the sequence of actions presented in it. Within the exercises, the steps were repeated two to three times as the guidance provided by the RAs was reduced to increase difficulty. For Levels 2 and 3, sample structured practice exercises were provided as a template from which the remaining exercises could be completed.

Level 2 training provided for simple instruction in node operations, crewman's access unit (CAU) radio and intercom use, and basic operation of the plan view display (PVD), whiteboard, and e-mail. Level 3 training then showed participants how to use the more advanced tools. Both training participants and SC^4 functions were grouped during Level 3 training, so that specific content was addressed to the specific users. The functional groupings that resulted from the system tool analysis were as follows:

- Common relevant picture management;
- Conference management;
- Information management;
- Orders production; and
- Other support functions (e.g., unmanned aerial vehicle [UAV] and battlefield planning visualization [BPV]).

For Level 3 training, use of some tools and functions (e.g., viewing snail displays and getting reports of enemy activity) required having virtual or constructive vehicles moving on the battlefield. Other functions (e.g., bringing up saved overlays and forwarding orders) required that prepared tactical products be available to participants. Scenario products from the BCR II were pulled from archives by the MMBL and stored on the SC^4 system to present the needed conditions.

Level 4 training built on the unit's basic SC^4 knowledge by providing them the opportunity to practice their functional system operation skills in a scenario-based context within their own nodes. No new system tools or functions were introduced; rather, the training consisted solely of structured practice exercises. The exercises focused on selected collective functions (determined from the initial analysis) that would be performed by small groups within the unit during battle staff training, and included:

- Commander's guidance
- Develop COA
- Order development
- Development of annex to an order

Because the Level 4 training was designed to be structured and scenario-embedded, a full TSP was developed for the training, rather than simply providing recommendations. The TSP included:

- ModSAF exercise files containing starting conditions and some scenario events;
- scenario event guides for use by the White Cell;
- scripted whiteboard messages from the Higher Headquarters;
- the Higher Headquarters Order with the Effects and Reconnaissance Surveillance Target Acquisition (RSTA) Annexes; and
- the Higher Headquarters operations overlay.

The training for the primary training audience was to be conducted under the direction of the Training Director, with RAs assisting at the nodes. Level 4 training was to be initiated with the transmission of the Higher Headquarters Order with Effects and RSTA Annexes. Each of the four nodes was to produce a specific product. As each node completed the output for each exercise, it was to be transmitted to the Command 1 node. The Squadron Commander would then initiate a conference with the other node officers-in-charge (OICs) to discuss the output result and provide guidance on his expectations as to content and format. When the Commander completed his review, the output would be sent to the other nodes to begin the next exercise.

During the structured practice exercises, the extended training participants also were to receive training using the same exercise files. This training was to focus primarily on a series of maneuver exercises followed by an engagement. The two groups, primary and extended participants, were also to be brought together for one combined activity during the Develop COA exercise. This was done to ensure the extended training participants, particularly the company commanders, were included in the decision-making and team process.

The training for the extended training participants was to begin when an order to conduct a terrain reconnaissance was transmitted to the company commanders under the direction of the Training Director, or his designee. The subsequent exercises would then be initiated by a similar electronic transmission of orders. Again, RAs were to assist with system operations at the nodes.

Another component of the Level 4 training was the introduction of the staff process training. This training was designed to involve two one-hour sessions, one on Information Management and another on Roles and Functions. The training sessions were to be conducted in a classroom setting. A series of slides and activities were developed that detailed the information found in Table 2.

Table 2

Level 4 Team Training Session Descriptions

Training Session	Information Provided
Information Management	Generic "information management" exercise to highlight difficulties
	Required knowledge for information management
	Model of information management
	Errors in information management
	Low level strategies and solutions (e.g., e-mail formatting protocols)
	High level strategies and solutions (e.g., understanding commander's intent)
Roles and Functions	Short lecture on the importance of roles and functions
	Connections between roles and functions and decision-making, coordination, and information management
	Discussion of how the unit members perceive their roles and functions for the upcoming BCR III
	Format for the unit to use to self-correct during the exercise if the need arises

The TDXs, Level 5 training, were the culmination of the squadron level train-up for the BCR III. All of the materials and information for Level 5 are contained in Training and Measurement Support Package Volume 3 (1999) and examples of the materials can be seen in Appendix D. While the initial training was to focus primarily on individual skills and functions within the node, the TDXs were designed to provide a battalion or squadron battle staff the opportunity to apply these skills and functions to accomplish collective battle staff tasks using SC^4 tools. The Training Director would control the flow of the TDXs. The RAs, members of the White Cell, and OPFOR Controller would provide support but would not be in control of the TDX training.

The four TDXs shared a common tactical scenario and were projected to last 4-8 hours each. The events paralleled situations contained in the trials. They were designed to assist the squadron participants in organizing and performing common battle staff collective tasks. Descriptions of the TDXs are provided in Table 3.

Table 3

TDX Objective Descriptions

TDX	Objective
Mission Analysis and Wargaming	Provided the battle staff practice on the decision-making process. The battalion or squadron conducted a roadmarch based on a movement order provided in the tactical materials. As they conducted their movement, they received an order, intelligence summaries (INTSUMs), and defensive battle force order. The battle staff developed and issued its order as it completed its movement, occupied an assembly area (AA), and established a screen line for security.
Rehearsal	Provided the battle staff and company commanders practice conducting a virtual rehearsal. The squadron completed its preparations within the AA and rehearsed the plan developed during TDX 1. Near the end of the exercise, the squadron received an INTSUM that OPFOR reconnaissance had crossed the international border (IB), and was instructed to establish its defense.
Execution of a Battalion or Squadron Branch	Provided the battle staff practice in modifying and executing a branch to an existing plan during operations. As the squadron moved to its defensive sector, it encountered and was to destroy enemy reconnaissance elements. The exercise ended with the squadron occupying its defensive sector.
Execution of a Brigade Sequel	Provided the battle staff practice with planning a future operation while executing a current mission. As the squadron executed its defense to defeat a forward detachment, Higher Headquarters issued fragmentary order (FRAGO) to its defensive battle force order. The FRAGO required the 2 Squadron to conduct an on order (O/O) counterattack to defeat a first echelon motorized infantry brigade (MIBR) from the flank.

The materials developed in support of the TDXs were based on the methodology for development of structured simulation based training (Campbell et al., 1995; Campbell & Deter, 1997; Flynn et al., 1998). The materials included:

- Overview
- Event Description
- Event Guide
- OPFOR and Blue Forces (BLUFOR) Workstation Guideline
- Tactical Materials
- Plan Sheets
- Training Director Guidelines

Embedded in each TDX were three team training sessions that focused on the unit's decision-making and team functioning skills. The description of each training session is shown in Table 4. The team training sessions were to be initially facilitated primarily by the Training Director. The intent for these sessions was to have the Squadron Commander take over responsibility in leading these training exercises as the TDXs progressed.

Table 4

Level 5 Team Training Session Descriptions

Team Training Session	Objective
Pre-Action Analysis	Focus staff attention on shared understandings of roles and functions, information management, workload, and situational awareness. The purpose is to anticipate potential problem areas and help generate how they will solve problems should they arise. These sessions will also allow time to review those action items identified in previous debriefs for sustainment or improvement.
Commander's Timeout	Recalibrate the team to the Commander's situational awareness. The benefits of performing a Commander's Timeout are that it causes the Commander to stop and think about his situational awareness and to communicate that to the staff. It allows the Commander to gain information to questions he may have and help the team to focus on keeping the Commander aware of the ground truth.
Team Decision-Making Debrief	Focus on issues related to team processes, decision-making, roles and functions, and information management. The team will also identify action items for sustainment and improvement.

These sessions were designed to train information management, decision making and teamwork skills. The sessions were to occur before, during and after each exercise, respectively. The pre-action analysis was to begin with the exercise director explaining the tactical situation for the exercise. Then the commander would explain his goals for the exercise. Each of the node OICs would then discuss the node's role during the exercise. Finally, each staff member would list one challenge or show stopper that could occur during the exercise. These would be discussed and ways to deal with the challenges developed. The commander's timeout was to occur during the exercise at a point of uncertainty caused either by conditions of the situation or staff. The commander would explain what is happening, what information is needed, immediate goals, and what will occur in 30 to 60 minutes. The team decision-making debrief was to occur after the exercise. First the commander would discuss a difficult decision made during the exercise, what information was available and what information was not. Each node OIC would then discuss their node's role during that decision. Finally, node OICs would discuss their own difficult decisions.

The team training sessions build on the Klein, McCloskey, et al. (1997) Decision Skills Training program described earlier in this report. The Decision Skills Training program was focused on improving individual decision-making skills. While maintaining the focus on decision-making, the team training sessions are broader in scope to focus on training decision-making skills in an Army battalion-level staff operating as geographically separated teams as it plans, prepares, and executes tactical missions.

Performance Evaluation Methods

Embedded in the requirement to design and develop a prototype training package for future battle staffs is the need to evaluate the performance of the staff after it has received the training. Existing standards for measuring the performance of battalion-level staffs (DA, 1988)

were reviewed and deemed to have very little direct application to future staff training evaluation since they are based on a staff organization and analog decision-making process that would not be used during the BCR III. Draft training and evaluation outline standards incorporating current battalion-level digital technology at the battalion level (U. S. Army Armor Center [USAARMC], 1997) were also reviewed and not adopted for the same reasons. As a starting point for evaluation, the Battle Lab Experiment Plan (BLEP) for the BCR III (Mounted Maneuver Battlespace Lab, 1998b) identified several issues related to advanced digitization's effects on battle command at brigade and below[1] that could form the basis for developing future staff training performance standards. The central issue was: If the commander is provided timely, accurate, decision-centered information that allows him to visualize the battlefield, how is the commander's ability to conduct battle command improved?

Earlier BCRs demonstrated the potential for value to be added to battle command by using advanced digital C^4I systems. However, the BCRs did not focus on the commander's need to visualize the battlefield and the staff organization and process that would support him. The BCR III would provide this focus by examining battlefield visualization and ways to improve it through the use of more complete information flow, more optimal structuring of the staff, and training in ways to optimize use of the information. The three issues of interest were:

- How effectively does the objective C^4I system enable the commander to visualize the battlefield?
- What efficiencies in speed, knowledge, and manning requirements are gained from reengineered battle command?
- What are the major impacts of reengineered battle command across the spectrum of doctrine, training, leader development, organizations, materiel, and soldiers (DTLOMS)?

The BCR III hypotheses were based on six overarching hypotheses:

- The objective C^4I system will provide timely, required critical information requirements.
- The objective C^4I system will provide the necessary capabilities for the key nodes to meet the commander's critical information requirements (CCIRs).
- The revised MDMP will enhance the span of control in tactical operations.
- The objective C^4I system will enhance synchronization of assets.
- The objective C^4I system will provide information to assist the commander's decisions.
- The objective C^4I system will facilitate multifunctionality.

Since the future battalion battle staff model that the project team was using to develop the training did not have published doctrine or tactics, techniques, and procedures upon which to base training and performance evaluations, the MMBL issues were used as a starting point.

A total of 10 questions, derived from the three MMBL issues, were addressed by the performance measures. The measurement would be multifaceted, involving a combination of automated measures, surveys, observations, and interviews. Specifications for the evaluation

[1] Information for this section of the report has been adapted from the BLEP (MMBL, 1998b).

plan began with analysis of the questions and determination of the methods that could best be used to address each question. The specific measures (e.g., survey and interview questions, observation points) were then designed and developed to provide broad yet efficient coverage of the issues.

Measures Analysis

The goal was to address each question by at least two methods, to increase the reliability and validity of the data and interpretations. Additionally, each method has recognized strengths and weaknesses. For example, interviews can potentially provide a wealth of information on various questions, as participants explore issues either individually or in a group; however, they are time-consuming to conduct and difficult to analyze and summarize. Survey data are more easily obtained, requiring less participant time, but do not usually yield lengthy explanations or comments. The intent was to exploit the method strengths but not compromise the utility of the data-collection opportunities. Table 5 portrays the matrix of research questions and the measures used to evaluate them.

The use of automated measures was focused on the first six MMBL issues. Although the target variables in the MMBL issues (e.g., efficient synchronization, span of control) were not directly measurable by objective data, simulation-produced measures could provide partial information on the issues. The automated measures were gathered by the MMBL's Data Collection and Analysis System (DCA) during the virtual simulation used in the BCR III. The DCA is a set of tools designed to collect, reduce and analyze battlefield performance, command and control, communications, and other types of data in distributed simulations.

Surveys were used for four of the team process and decision-making issues. Within the NDM model and training design, the focus was on three core skill areas: decision-making, information management, and team performance. The surveys focused on perceptions of teammate roles and responsibilities, workload, communication load, and process. It was expected that high performance teams would share awareness and knowledge of individual roles in the larger team, the distribution of load, and the overall goals of the shared mission. While improved situational awareness might foster team communication and awareness of the activities of others in the team, it could prove overwhelming, leading to information overload and a loss of focus on the command decisions central to the job. The surveys were designed to begin to achieve a greater understanding of these issues.

The observation-based measures were used to provide additional information on five of the questions by focusing on qualitative aspects of performance that are hard to capture using automated means. Five key aspects of performance were designated for observation focus:

- Communication: the exchange of information between two or more team members in the prescribed manner and using proper terminology.
- Monitoring: how well team members observed the activities and performance of other team members.
- Back-up: how well team members assisted the performance of other team members.

- Coordination: whether team members executed their activities in a timely and integrated manner.
- Team orientation: the commitment exhibited by team members working together.

Table 5

Questions Addressed by Each Measure

Question	Measure Types			
	Automated	**Survey**	**Observer**	**Interview**
1. Can the Reengineered Battle Command (RBC) decrease the time for planning and increase the time to prepare and rehearse?	X			X
2. Can the RBC provide the information and support system to assist the Commander's decision-making process?	X	X	X	X
3. Can the RBC allow efficient synchronization of combat, combat support, and combat service support assets?	X		X	X
4. Does the RBC provide efficient battle tracking and facilitate precise execution?	X		X	X
5. Does the RBC contribute to more rapid and efficient destruction of enemy forces?	X			X
6. Can the RBC increase the span of control of the Commander?	X		X	X
7. What effective tactics, techniques, and procedures (TTPs) are emerging from the RBC process?				X
8. What are the information management demands on multi-functional officers and what are the impacts of these demands on individual and team performance, process, and training requirements?		X	X	X
9. What are the impacts of RBC on team performance and process and how do new tools, capabilities, and roles change the task force organizational architecture?		X		X
10. What are the impacts of RBC on perceived and actual workload, the attribution of workload to individual, team, and task demands, and individual awareness of the distribution of workload across the team?		X		

The interviews were used to provide information on any issues not completely covered by the other measures as well as to allow participants to expand on their responses to any open-ended survey questions. They would be conducted by project team members familiar with the design of the prototype training package and the MMBL's objectives for BCR III.

One of the difficulties in designing specific measures for the MMBL issue-based questions was that the questions had not previously been addressed, thus lacking both instruments and baseline data. For those issues where the interest was in improvements (e.g., "increase the time" or "contribute to more rapid destruction"), measures in BCR III would be examined as a possible way to establish a baseline for future BCRs.

Measures Design and Development

The specific content and format of each of the four types of measures is described below. Copies of the data collection instruments are contained in Training and Measurement Support Package Volume 4 (1999).

Automated measures. The automated measures were designed to answer specific issues regarding the effectiveness and efficiency of the reengineered Battle Command. The questions, the specific measures of performance designed to address them, and descriptions of their operational definitions can be seen in Table 6. Although these measures do not tell a complete story about staff performance on their own since they are focused on outcomes rather than processes, they become more informative with the addition of the process-oriented measures.

Table 6

BCR III Questions and Automated Measures of Performance

Question	Measure of Performance	Description
1. Can the RBC decrease the time for planning and increase the time to prepare and rehearse?	Battalion staff communication patterns	Total time spent using each of the communication tools for each node position for each planning and execution session
2. Can the RBC provide the information and support system to assist the Commander's decision-making process?	UAV mission effectiveness	Number of OPFOR vehicles first detected by UAVs divided by total number of OPFOR vehicles detected
	Percent of enemy vehicles inside the battalion's area of responsibility that were detected	Number of unique OPFOR vehicles detected by sensors, scouts, or weapons systems controlled by the battalion divided by the number of OPFOR vehicles
	Percent of enemy vehicles inside the battalion's area of responsibility that were never detected	Number of unique OPFOR vehicles not detected by sensors, scouts, or weapons systems controlled by the battalion divided by the number of OPFOR vehicles
	Use of SC^4 communication tools during mission	Total time spent using each communication tool and the number of communication tool initiations per mission for each node position

(table continues)

Table 6 (Continued)

Question	Measure of Performance	Description
	Use of Stealth Control, Terrain Tool, Field of View Tool, Snail Display, and Forward Line of Troops Display during mission planning	Total time spent using each tool and the number of tool initiations for each node
3. Can the RBC allow efficient synchronization of combat, combat support, and combat service support assets?	Percent of OPFOR kills inside effects box	Number of OPFOR kills in effects box divided by total number of OPFOR kills
	Ratio of indirect to direct fire OPFOR kills	Number of indirect fire kills to number of direct fire kills
4. Does the RBC provide efficient battle tracking and facilitate precise execution?	Percent of OPFOR vehicles engaged from flank or rear	Total number of flank or rear engagements on OPFOR vehicles divided by total number of OPFOR vehicles
	Percent of BLUFOR vehicles engaged from flank or rear	Total number of flank or rear engagements on BLUFOR vehicles divided by total number of BLUFOR vehicles
	Average range of OPFOR fire engagements	Average range of friendly weapon systems, by type, against OPFOR vehicles that were killed during a mission
5. Does the RBC contribute to more rapid and efficient destruction of enemy forces?	OPFOR vehicle kills by friendly weapons types	Number of OPFOR vehicle kills by friendly weapon types during the mission
	Time to destroy OPFOR	Time from first OPFOR engagement until OPFOR vehicle losses exceed 70%
6. Can the RBC increase the span of control of the Commander?	Number of subordinate unit leaders Squadron Commander personally contacted during mission execution	Commander's frequency of and amount of time for use of communications tools across each of the different personnel with which he interacted during mission execution

Note. Area of responsibility is delineated by its rear, flank, and forward boundaries assigned by its higher headquarters.

Survey measures. The surveys that addressed the MMBL issues were designed to be completed by the primary training audience at the conclusion of the training week and on each day of the pilot test and trials. There were five surveys, as described below.

The Organizational Awareness Survey was designed to determine the extent to which each member of the team is aware of the roles and activities of their teammates during mission execution. The items on the survey were to provide a record of what each individual thought every other individual was doing at a particular time. This would lead to an understanding of whether the system of tools and capabilities introduced in BCR III impact team process and performance via improved abilities to acquire and maintain team-level situational awareness.

The Operations Planning Survey was designed to assess the extent to which trained behaviors are practiced in the planning and rehearsal stages of each mission. The data could help to determine whether the use of enhanced planning support tools provides the staff with improved plan knowledge and preparedness for communication and coordination, and whether these things impact individual understanding of roles in the mission.

The Information Management Survey was designed to track the information management demands of each mission and collect data on the information management behaviors practiced during each mission. By collecting these data, the match between participants' perceptions of the sources of information management load and the actual sources could be assessed. The major issues to be investigated through this instrument centered on the extent to which the system of tools supported manageable, effective communication and coordination as well as awareness of the communication loads imposed on the team. With so many options to choose from, a whole new class of decisions is introduced by the communication tools provided. The degree to which individuals are able to track and predict information load, choose the right tools for the job, and coordinate effectively without information overload are all empirical questions. Answers to these questions may provide a foundation for standing operating procedures (SOPs) or TTPs in future BCRs.

The Individual and Team Workload Survey[2] was designed to assess individual workload as well as individuals' perceptions of the workload faced by teammates in other nodes. Team workload measures are predictors of team performance and may provide insight into the impact of training as well as the ability of the system to support awareness of the rest of the team. The basic question to be answered was whether the system of tools introduced in BCR III enhanced the abilities of the staff to appreciate and maintain situational awareness of the workload across the staff and whether this ability changed with practice as a team.

The Communication Load Survey was designed to assess the degree to which participants' perceptions of information management load across the team match to objective data. The accuracy of such perceptions is important because those perceptions provide the basis for individual decisions to send information, request information, and time communications. It was expected that performance would be related to the ability to predict the information management load of others.

Observations. The observation data were time-stamped information elements collected on laptops by trained data collection observers. To assist the observers with this effort, the Observer's Data Collection Instrument (ODCI), a software program created with Microsoft Visual Basic®, was developed. By entering a last name, the name of the exercise, and the node being evaluated, the observer was then led into the specific events that would cue the desired behavior. Each event was described in detail and a picture of the graphic control measures used during the event was also provided. Data collection observers also had space to provide comments on any of the behaviors. At the conclusion of the exercise, the observer ratings and comments were stored in a word document file that could readily be downloaded for analysis and feedback. Sample screens and output documents can be seen in Appendix E.

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[2] Adapted from NASA-Ames Research Center, Human Performance Group. (1986). Collecting NASA workload ratings: A paper-and-pencil package (Version 2.1). Moffet Field, CA: NASA-Ames Research Center.

The information collected was based on the five teamwork behaviors described earlier. Each behavior was observed and rated on a 7-point scale. Data collection observers also had space to provide comments on any of the behaviors. The specific questions for each of the five behaviors measured are provided in Table 7. The measures were collected for the planning and execution phases of each mission. In addition to these five behaviors, observers also rated the overall team performance, both for the node they were observing and for the Squadron as a whole.

Table 7

Questions Addressed by Observation Data

Behavior	Questions
Communication	1. To what extent were errors caused by inadequate within-node communication?
	2. To what extent were errors caused by inadequate team communication?
	3. To what extent did node members provide relevant information to another node member, in a pro-active way, without that node member having to ask for it?
	4. To what extent did the node provide relevant information to other nodes, in a pro-active way, without the other nodes having to ask for it?
Monitoring	1. To what extent did node members alert each other to impending decisions and actions?
	2. To what extent did the node alert other nodes to impending decisions and actions?
Back-up	1. To what extent did node members anticipate the need to provide assistance to other node members?
	2. To what extent did the node anticipate the need to provide assistance to other nodes?
	3. Did the node members adjust individual tasks and responsibilities to prevent overload?
	4. Did the node adjust individual tasks and responsibilities to prevent team overload?
Coordination	1. To what extent was the behavior of individuals in the node coordinated?
	2. To what extent was the overall team's behavior coordinated?
Team Orientation	1. How congruent/similar were individual node members' understandings of their role in the mission?
	2. How congruent/similar were node members' understandings of the role of the node in the mission?

Note. Each question was rated on a 7-point scale.

Interviews. Protocols were prepared for structured interviews to be conducted with individuals and small groups, consisting of the observers and training audience members. The interviews were conducted on the last day of the BCR III, and the actual protocols are presented in Training and Measurement Support Package Volume 4 (1999). Within the training audience, interviews were scheduled with the following:

- Commander
- Deputy Commander
- Effects Officer and Enemy Operations Officer
- Control Vehicle Battle Captains
- Enemy operations personnel from Command 2, Control 1, and Control 2
- Friendly operations personnel from Command 2, Control 1, and Control 2
- Company commanders

The training audience was segmented into groups of individuals with similar tasks and responsibilities in order to encourage an open conversation and enable data collection from different perspectives. Each group was made up of personnel with the same ranks in order for all group members to be able to express their opinions without the discussion being dominated by the highest-ranking individual. The time for each interview was limited to 1 hour. Because of the restricted time available, the scope of each group's interview was limited to focus on insights that were not obtained by survey, observation, or automated data collection methods.

Pilot Implementation of the Prototype Training and Evaluation Package

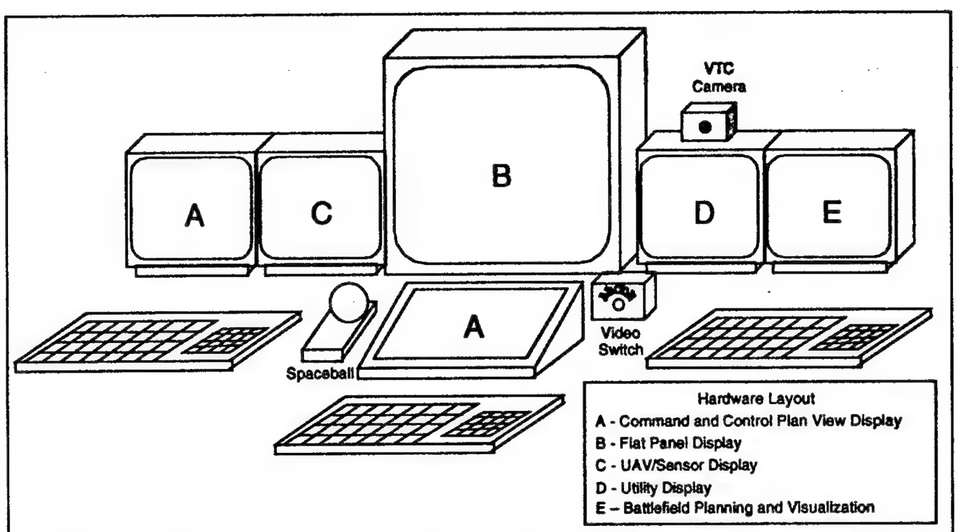
As described previously, parallel to the early conceptualization of the training need on which this project is based, the MMBL was in the initial stages of planning for their BCR III. (A thorough description of the BCR III design appears in *Battle Lab Experiment Final Report [BLEFR] for Battle Command Reengineering, Phase III* [1999]). It was known from the results of the earlier BCRs that participants needed more structured training on operating the digital system and operating within a reengineered staff structure. An intact squadron staff was scheduled to participate in the BCR III, so that there would not be the problem of providing entry-level staff training. Thus all of the assumptions underlying the general training recommendation for the prototype package were satisfied. The ARI and the MMBL agreed to work as a team to effect mutual support of each others' goals.

Therefore, the general training design was tailored for use in the BCR III which would allow for a pilot implementation using MMBL personnel as the trainers. An added benefit was ARI would be able to conduct a formative evaluation of the prototype training package. The specific design characteristics of the BCR III which the project team considered in tailoring the prototype training package are described below. The description covers virtual and constructive simulators, the scenario conditions, training audience, commander and staff organization, and training timeline.

BCR III Simulators

The BCR III used emulation as well as constructive and virtual simulators. Figure 3 shows the sample layout of the SC^4 system hardware for the BCR III. The Effects or Enemy Operations Officer is positioned on the left. The node officer in charge (OIC) is seated in the center, with the Friendly Operations Officer or NCO seated on the right. The SC^4 system included the following capabilities:

- A- Command and Control Plan View Display, represented by the ModSAF two dimensional PVD. On the PVD, Node OICs are able to view movements of all of their own systems, as well as any OPFOR units detected by satellite or other sensors. Overlays can be drawn on the PVD, users can add labels or other notes, and there are tools that show past events and project future movements.
- A- Digitized modified combined obstacle overlay (MCOO), produced automatically for the flat panel display, rather than as a manually produced intelligence overlay.
- B- Flat Panel Display, providing a 3-dimensional representation of the battlefield with all of the systems that are visible on the PVD (i.e., friendly and detected OPFOR).
- C- Unmanned Aerial Vehicle (UAV) sensor display, with video footage of area currently under surveillance by UAV.
- D- Utility Display with video teleconference (VTC) capability linking the commander and his staff.
- D- Collaborative whiteboard capability, to allow the commander to present his intent and guidance to the staff visually and quickly. Users who are part of the whiteboard session can show snapshots from their PVDs, draw in different colors on those images, add clipart-style labels and icons, and type words onto the whiteboard.
- E- Battlefield Planning and Visualization (BPV) , a system that allows the commander to plan, rehearse, and monitor execution of missions through a 2-dimensional/3-dimensional interface.
- E- Satellite imagery, acting as the electro-optic satellite sensor to deliver a direct downlink imagery feed.



Note. Reproduced from *Battle Command Reengineering III User's Manual for the Battle Command Reengineering III Battle Lab Warfighting Experiment* (Mounted Maneuver Battlespace Lab, 1999a).

Figure 3. SC[4] system hardware layout for BCR III.

Vehicles and weapon systems were represented in either constructive or virtual simulation. Constructive simulation (ModSAF) was used to generate and control the OPFOR, friendly forces below the company level, and unmanned vehicles replicating both aerial and ground sensors (referred to as UAVs and unmanned ground vehicles (UGVs), respectively). Constructive simulation workstations were used by the fire support element commander, forward support company commander, two of the maneuver company commanders, and the three platoon leaders of another maneuver company.

In the virtual environment, simulators were used to represent several vehicles. These included the battalion commander and deputy commander vehicles which were represented by the Advanced Research Projects Agency (ARPA) Reconfigurable Simulator Initiative (ARSI) simulator and an ARSI mockup, respectively; staff operations vehicles (SOVs) which were represented by command and control vehicle (C2V) mockups; and scout vehicles which were represented by Future Scout/Cavalry System mockups. The virtual and constructive environments were linked by means of distributed interactive simulation (DIS) to form the seamless battlefield environment for the participants.

Trial Scenario Conditions

For the BCR III, the scenario covered a tactical movement and six mission segments, each requiring approximately one day. The sequence was as follows:

1. Tactical movement and defense: The unit conducted a tactical movement from its initial location to an assembly area where it received an order to defend. The rest of the day was spent planning and preparing for the defense.
2. Defense: The unit executed the defense that it had planned and prepared against an OPFOR Motorized Rifle Regiment (soon to be called a Mechanized Infantry Brigade).
3. Movement to Engagement: The unit moved to engage an OPFOR Motorized Rifle Battalion operating as a flank guard.
4. Defense: The unit defended against an OPFOR second echelon Motorized Rifle Regiment.
5. Movement to Engagement: The unit moved to engage an OPFOR tank battalion maneuvering as a forward detachment.
6. Defense: The unit defended against an OPFOR Motorized Rifle Regiment from a Second Echelon Division.
7. Movement to Engagement: The unit moved to engage a Motorized Rifle Battalion attempting to link up with an air assault force.

For each mission, the unit readiness conditions were reset within the simulation. Thus, the battalion staff's combat service support (CSS) activity did not have any real impact from one mission to the next. A single integrated storyline was constructed to underlie the missions.

Both the friendly and enemy forces were configured as nontraditional future forces, in terms of equipment, organization, and doctrine. The enemy forces comprised a regimental-sized Heavy-Light Maneuver Group. The MMBL evaluated several friendly forces concepts by means

of simulation modeling between November 98 and January 99 to determine which concept was best able to defeat the enemy. Results of that evaluation are reported in *Battle Lab Experiment Final Report (BLEFR) for Battle Command Reengineering, Phase III* (1999).

In addition to the six mission segments, there were also six planning segments for missions that would not be executed. This concurrent planning and conduct of missions would allow the MMBL to examine and refine the battalion organizational structure for current and future operations.

<u>BCR III Participants</u>

The primary training audience (14 members) comprised the commander and selected staff of an active Army cavalry squadron. The primary training audience was augmented by an extended training audience (21 members), which included three maneuver company commanders and their deputies, three maneuver platoon leaders and one mortar platoon leader for one of the companies, a battery commander and his deputy, a forward support company commander with his deputy, and the scout platoon leader and platoon sergeant. A total of 35 soldiers from the squadron participated in the BCR III as members of the primary training audience and extended training audience.

A team of RAs was formed to conduct the system training and assist during the BCR III trials. The RAs began their preparation two weeks prior to the train-up week to learn how to operate the SC^4 system. Four of the RAs provided technical assistance and system troubleshooting at the nodes during the trials, while the others served as workstation operators for the company- and platoon-level and OPFOR workstations.

A White Cell was also formed to provide brigade-level context-based guidance for the squadron. The White Cell included both MMBL personnel and active duty military personnel in the roles of Battle Force Commander, Intelligence Officer, Operations Officer, Fire Support Officer, and Logistics Officer.

<u>Commander and Staff Organization</u>

One major feature for the BCR III was the reengineered battalion command group structure for the primary training audience, depicted in Figure 4. It comprised four staff nodes: the command group node (Command 1), the deputy commander node (Command 2), the current operations node (Control 1), and the future operations node (Control 2). Each node was staffed by 3 or 4 primary staff members.

This structure was similar to the structure settled on by the BCR II battalion commander. The BCR III training audience began with this structure, and was given some information about the roles and responsibilities of each staff member in each node. As the BCR III progressed, the battalion commander was allowed to realign roles and responsibilities to try out different structures.

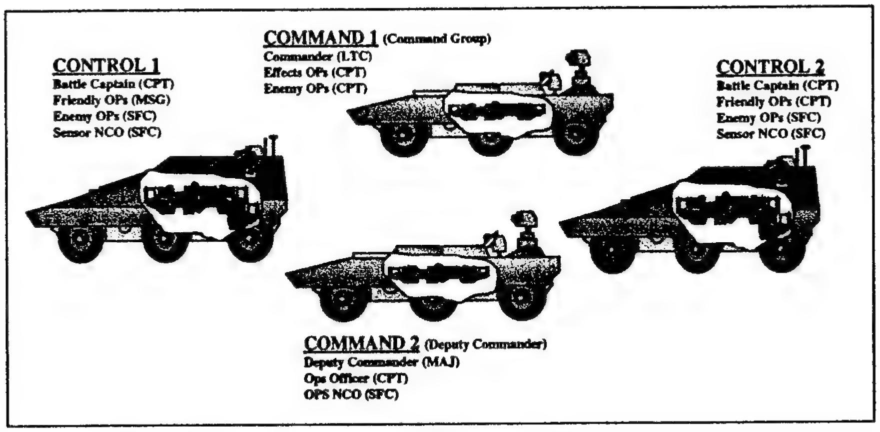


Figure 4. Reengineered battalion command group structure.

BCR III Timeline

During the three-week period, the events included 5 days of participant training, a 2-day pilot test, and the 7-day trial (see Figure 5). The participant training included ModSAF familiarization as well as training on staff processes and decision-making (primarily to ensure a common working model of the processes) with special attention to the staff processes in digital environments. This train-up concluded with exercises in mission planning and execution to reinforce the ModSAF training and allow time and input for the commander to refine the staff processes. The pilot test consisted of a "rehearsal" of the trials and data collection procedures.

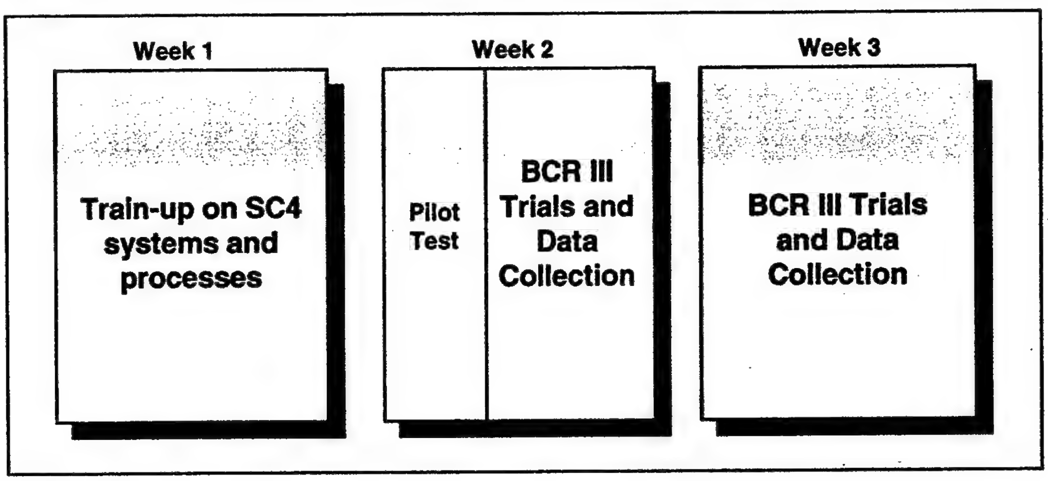


Figure 5. BCR III schedule.

The trials involved the squadron in planning, preparation, and execution of six missions, equally divided between offensive and defensive operations. The squadron was issued a brigade operations order (OPORD) which established tactical tasks for the unit and set the conditions under which it would operate. Subsequent FRAGOs modified the tasks and conditions as the BCR III progressed from one mission to another. Feedback sessions (referred to as hotwashes) were conducted after each mission to identify software or hardware performance shortfalls, to elicit participant recommendations for improving the system, and to explore the objective SC^4 system's impact on future DTLOMS.

Changes During Pilot Implementation

The most significant changes from the prototype future staff training package that occurred during the pilot implementation included:

- Unit preparation: Since the unit did not have detailed preparatory materials before coming to the BCR III, they worked on development of staff processes and techniques that were not based on BCR I and II discoveries, and that were not entirely in line with the assumptions underlying the Level 2-4 training.
- Entry level skills: Another assumption for the training was that the staff members would be familiar with their duties and responsibilities in a conventional staff configuration. Due to normal turbulence within the unit, however, many of the staff members were relative novices in staff operations. This meant that some of the training was too intensive, attempting to build on skills that the individuals were lacking. As a result, the time allotted for Levels 2-4 was extended, leaving less time than planned for the TDXs.
- SC^4 equipment use: The BCR III plans called for use of helmet-mounted displays (HMDs) for all members of the Control 2 node, rather than the normal computer screen displays found in the other nodes. The training was structured to provide separate training for personnel in that node, so that they could use the HMDs at all times. This compromised the Level 3 training, where participants were to be grouped for training according to their node roles, rather than being grouped within their nodes. Even before the end of the training week, the MMBL determined that the HMDs were not effective, and in fact caused equipment failures. As a result, participants were switched to the normal display modes, but by that time they had already begun to participate in Level 4 training.
- Training schedule: The plans for the train-up in the program of instruction (POI) were within the allotted time of five days, but there was very little room for adjustment. Several additional activities (e.g., satellite training) were inserted into the training week, which extended the training day for some soldiers.
- Training session direction: Early design and development of the Level 4 and Level 5 staff process training had proceeded on the assumption that the sessions would be facilitated by members of the project team. Later it was determined that the Level 5 sessions would be initially conducted by the MMBL Training Director and later transitioned to the Squadron Commander. Because the Training Director's time was limited during the week prior to the BCR III, efforts to prepare him for that role were similarly limited. Since time was limited during the training week to brief the Squadron Commander on the design of the team training sessions, he was unable to fully implement the requirements.
- Performance feedback: There were three related issues that completely compromised the performance feedback plans. First, the evaluation plan was based on the assumption that survey data would be collected by means of computer-based software systems that would allow very quick summaries of results that could be used for feedback. Second, the automated data collection, using the DCA, was assumed to have been quickly available for feedback. Third, team training sessions that were conducted during the training week were to have continued into the trials. However, use of the survey software would have led to an increased risk for data security as well as increased data reduction loads, so surveys were administered in a paper-and-pencil mode and could not be summarized for feedback quickly. The DCA routines for automated data collection were not available prior to the BCR III, but

rather were deferred to post-BCR processing of the data. Finally, no team training sessions were scheduled during the trials.

The bottom line for these changes was that some results of the formative evaluation did not address the prototype training package design, and therefore data for performance feedback purposes were either not available or not used.

Formative Results

As discussed earlier, data was collected during BCR III for two purposes. The first purpose was to gain insight into how the prototype staff training package could be improved. The second purpose was to gain experience in developing performance evaluation methods for future brigade and battalion-level staffs using advanced C^4I systems and operating in geographically dispersed locations on the battlefield. Results from both are presented in this section.

Prototype Staff Training Evaluation

To evaluate the utility of the prototype training package and to document lessons learned for future training development, data were collected from the training participants by means of surveys, interviews, and observations. Training evaluation surveys were administered seven times: at the conclusion of Level 2, Level 3, Level 4, TDX 1, TDX 2-3, TDX 4, and end of BCR III. Interviews were conducted at the conclusion of training and at the end of the BCR III. Observations were documented continuously throughout the training.

For this project, the data collected concerning the Level 5 training of TDXs were of particular importance and interest. However, the training that was recommended for the RA preparation and for the earlier part of the train-up week (Levels 1, 2, 3, and 4) was also of some interest. While the project team had not been responsible for the RA training nor for the completed Levels 1-3 training, and had only partial responsibility for Level 4, a sizable body of data was obtained that could inform revisions to the training for future BCRs and for other future staff training for the Army. Therefore, results pertaining to RA training and Levels 1-4 will be presented first, followed by more in-depth reporting on the Level 5 TDXs and Team Training Sessions. The Training and Measurement Support Package Volume 5 (1999) presents the survey comments and summaries of the interviews. Examples of the survey and interview data can be seen in Appendix F.

Evaluation of Training for Research Assistants

Information on the RA preparation was obtained primarily from interviews with the RAs themselves, but is also supported by comments on the surveys from the training audience members. The RA training was planned for the two weeks prior to the start of the BCR III. It was planned that they would receive SC^4 system training the first week and have the second week available for "practice teaching" (with an audience) and additional individual practice.

The comments received from the exercise participants, as well as the RAs, generally centered on the need for the RAs to be better prepared. Though several people indicated the RAs were familiar with the SC^4 system, RAs felt they lacked the depth of knowledge necessary to fully train and support the unit. The RAs indicated they felt that their training was somewhat unstructured. They indicated they would have benefited by having a "full-time instructor" available that first week to thoroughly train them on the system tools. The RAs stated that they did not realize that the training plan outlines provided to them were developed for them to use as a guide to train the unit members. The RA training coordinator commented that their training could have been more structured and better organized.

Another concern noted by both the RAs and the RA training coordinator was that the second week plan for practice teaching never came to fruition. For the most part, the individuals slotted to be their training audience were unable to attend as planned. The RAs stated they had at best a few hours the second week with someone there to receive training. They felt the lack of practice teaching hampered their ability to present the information as it was structured.

In general, the RAs and the training coordinator found the training plan outlines to be correct and potentially useful, both for their own preparation (supplementing formal instruction) and as a checklist to use in training the participants. The RAs pointed out that some sort of checklist for them to use would have helped to structure the training more effectively.

Levels 1-4: SC^4 Training

Although the surveys and interviews did not specifically address the Level 1 training (initial orientation), participants did provide some comments, both on the surveys and in interviews, on how it could be improved. The most frequently voiced comment was that the orientation should be reduced or dropped in favor of more practice or hands-on training time. Several participants reported that the on-site briefing was a repeat of what was presented at their home station, while others commented that it seemed to be addressed to upper echelon leadership rather than to the participants themselves.

The on-site briefing was not structured as a Level 1 advance organizer. As a result, some participants indicated that they did not know how the training was organized and what they were expected to learn; the RAs also indicated that the orientation did not clearly present the training topics and how the training would be conducted. Participants suggested changing the names of the levels of training to something more meaningful, or explaining the levels more clearly. They also suggested additional topics, such as supply and logistics information, enemy capabilities, and BLUFOR system capabilities. This information would have helped the participants considerably if it were provided during pre-BCR preparation or even in the initial on-site orientation. The RAs felt that information about operating the system itself should also have been included in the unit's preparation package, although the utility of such information would likely be limited because there would be no systems on which to practice.

The data collected from the training surveys for Levels 2-4 included ratings (Disagree/Agree) of statements as well as written comments on the statements. All statements were rated on a 5-point scale, ranging from "Strongly Disagree" to "Strongly Agree." Table 8 presents the means for each rated item. The items asked for a rating on several topics concerning training, including whether:

1. the day's training sequence was logical;
2. there was enough formal instruction during the training;
3. there was enough coaching during the training;
4. there was enough time to practice during the training; and
5. prior level(s) of training prepared them for the current level of training.

For all statement ratings, a "1" signified that the participant strongly disagreed with the statement, a "3" meant neither agree nor disagree, and a "5" signified that the participant strongly agreed with the statement. Standard deviations are shown in parentheses.

Table 8

Mean Ratings on Levels 1-4 Training

	Item Content				
Training Phase	Logical Sequence	Enough Instruction	Enough Coaching	Enough Time to Practice on SC^4 Systems	Prior Training was Helpful
Level 2	3.74 (0.74)	3.74 (0.66)	3.80 (0.72)	3.23 (1.24)	--
Level 3	3.54 (0.61)	3.74 (0.56)	3.89 (0.68)	4.09 (0.66)	3.74 (0.74)
Level 4	3.60 (0.69)	3.43 (0.88)	3.63 (0.73)	3.51 (0.95)	3.66 (0.76)

Note. Scale values were 1=Strongly Disagree; 2=Disagree; 3=Neither Disagree nor Agree; 4=Agree; 5=Strongly Agree. Dashes (--) indicate the question did not appear on that survey.

Overall, average ratings ranged from 3.23 to 4.09. For each statement and for each Level, the majority of participants gave a response of "4" or "5" (Agree or Strongly Agree); the modal response for each of the above statements for each Level of training was "4." This indicates that overall, the participants found the training to be adequate in terms of sequencing and amount of instruction, coaching, and practice.

However, within the overall positive reaction to the training, some items were somewhat less positively rated. On the item concerning the amount of practice time at Level 2, 35% of respondents (43% of primary training audience respondents) were somewhat negative, and their comments support the ratings. Several of them suggested more exercises and more hands-on time with the equipment as ways to improve the training, and two indicated that the pace of the

training was too fast, not allowing enough time to review and digest the information. In conversation with the participants, a number of them pointed out that they did not have a clear understanding of the structure of the train-up and no definition of the training objectives.

Comments on the Level 3 training again included the lack of explicitly-stated objectives, although respondents reported that they were beginning to understand the structure or flow of the training. They also expressed the need for more practice time, and the extended training audience indicated that they should have had more formal instruction at Level 3. Four respondents commented on the training pace: two indicated that the training was too fast, one felt it was too slow, and one recommended having a self-paced tutorial. However, they did begin to recognize the training progression, from individual to small group and from simple to complex (information which was included but not presented in the orientation). Two respondents suggested that the training should include structured practice exercises or some standards to evaluate whether the material had been learned. It should be noted that the training plan outlines did contain recommendations for structured practice exercises.

The training design for Level 3 called for members of the primary training audience to be clustered according to their jobs, so that those with similar functions would be trained together and they could begin to develop inter-node tactics, techniques, and procedures (TTPs) within functions. Respondent comments on this plan were mixed. Some recognized that the clustering provided opportunities for sharing ideas and techniques. However, at least one RA noted that it interfered with the learning on the system itself. The implication is that Levels 2 and 3 training should be more thorough before Levels 4 and 5 training begins.

There were several comments on the surveys and in the interviews concerning the underlying structure for the Level 3 training. As designed, the training contained partial scenarios with moving enemy units, fuel and ammunition consumption, and unit status reports. These scenarios provided the situation for showing various system functions. However, several respondents commented that they should have had such scenarios, apparently unaware that the information was already included. This speaks more to the implementation of training than to its design.

Level 4 training was their first opportunity to practice tasks in the context of a tactical scenario. As shown in Table 8, the responses were positive, but indicate room for improvement; the mode for all items was "4." The exception, at Level 4, was on the item concerning the utility of the prior training: 36% of the primary training audience indicated that the prior training was not helpful. Their comments covered a range of suggested improvements, including reorganizing the flow and sequence of topics like conferencing, providing for a more direct multi-echelon linkage during the exercises (e.g., having companies and platoons working more in concert with the squadron staff), giving more precise definitions of roles and functions for each node and position, incorporating more brigade-level interaction, and providing more practice on the UAVs and scout vehicles. Three of the comments indicated that the participants were beginning to develop TTPs pertinent to the planning process.

At the conclusion of the BCR III, the participants were asked again for their suggestions on the training, by means of surveys and interviews. The two primary comments during the

training were repeated: that the training objectives should be more clearly stated, and that the participants wanted more practice time. Their recommendations on the topics to be included in the training were focused on the SC^4 tools and on system capabilities. They requested (again) practice exercises, and two of the respondents suggested that the training be delivered by means of a computer-based tutorial. Several of the RAs and observer/controllers (O/Cs) also suggested using tutorials for individual training. While such an approach would allow each participant to receive standardized and structured instruction at an appropriate pace, it would not obviate the necessity for small group practice and collective training exercises. Small group and collective tutorials would require significant design and development work.

Level 5: Tactical Decision-Making Exercises

The data collected from the training surveys for the Level 5 TDXs included ratings (Disagree/Agree) of statements as well as written comments on the statements. Table 9 presents the means for each rating item. The items asked for a rating on several topics, including whether:

1. the prior training (individual and small group) prepared them for the TDX;
2. the TDX gave them the chance to practice using the SC^4 system;
3. the tactical materials were sufficient; and
4. prior TDXs prepared them for the current TDX.

Table 9

Mean Ratings on Level 5 TDXs Training

	Item Content			
Phase	Prior Training was Helpful	Enough Time to Practice on SC^4 Systems	Tactical Materials Were Sufficient	Prior TDX(s) Were Helpful
TDX 1	3.91[a] (0.37)	3.66[a] (0.97)	3.55[c] (0.71)	--
TDX 2 & 3	3.77[a] (0.65)	3.89[a] (0.87)	3.58[c] (0.66)	3.71[a] (0.62)
TDX 4	3.94[a] (0.48)	3.85[b] (0.74)	3.47[b] (0.89)	3.83[a] (0.51)

Note. Scale values were 1=Strongly Disagree; 2=Disagree; 3=Neither Disagree nor Agree; 4=Agree; 5=Strongly Agree. [a]N=35; [b]N=34; [c]N=33. Dashes (--) indicate the question did not appear on that survey.

For all statement ratings, a "1" signified that the participant strongly disagreed with the statement, a "3" meant neither agree nor disagree, and a "5" signified that the participant strongly agreed with the statement. Standard deviations are shown in parentheses. Once again, the mean ratings show that the general response was positive, and the modal response for every item was "4" (Agree).

On the first TDX, many comments again centered on the need for practice and repetition. Respondents also suggested the need for more training on specific functions, such as radio operations, flying the UAVs, creating and using graphics, tracking sensors, and driving the reconfigurable vehicles. Several of the primary training audience members felt that the pace of the training could have been a little more intense; the extended training audience members were more critical, stating that all they did was drive or move.

The focus for many comments on TDX 1 shifted from system issues to more tactical and staff process issues. The respondents indicated that they were in need of or were developing TTPs for various activities, including driver tasks, fire support element (FSE) techniques, and working with subordinate units. One participant requested TTPs from prior BCRs.

Comments on the scenario and tactical materials were specific and constructive. Two respondents were critical of the lack of logistics information and logistics requirements. Several comments concerned the perceived incompleteness of the brigade-level orders and graphics. For the most part, however, they indicated that the tactical cues for the TDX provided an adequate set of conditions for performance.

The TDXs 2 and 3 were conducted as a continuous activity, and therefore, separate comments on the two TDXs were not obtained. Responses on TDXs 2 and 3 were positive on the utility of the prior training, although they mentioned specific topics on which they wanted more training or information (logistics, training with subordinate units, non-line of sight [NLOS], overlays, and UAVs). Responses indicated that the training flow, from basic to more complex activities, was appropriate. They also felt that the prior TDX had provided valuable practice, although the importance of additional practice continued to be a focus. Several comments again indicated that the squadron was developing TTPs for planning, use of graphics, and use of the whiteboard conferencing.

The TDX 4 was the most intensive of the train-up phases, and respondents mentioned that it was painful but necessary. The insufficiency of CSS play was mentioned again as a drawback within the training. They continued to work out their TTPs concerning sending OPORDs, use of FRAGOs and warning orders (WARNOs), labeling tactical products that are saved on the system, and prioritization and dissemination of information.

In summary, participants focused their comments on the need for practice opportunities (at the expense of briefings and lectures, if necessary), explicitly-stated training objectives, and integrated training across echelons.

Team Training Sessions

In addition to evaluating training on the SC^4 systems, the participants evaluated the Team Training Sessions, including: the information management session (included in the Level 4 training), a roles and functions session (included in the Level 4 training), the Pre-Action Analysis, Commander's Timeout, and Team Decision-Making Debrief (all intended to be conducted throughout Level 5, in the TDXs).

In general, the evaluation data and comments from the training audience have limited validity and applicability for a number of reasons. The information management and roles and functions sessions were not evaluated explicitly in the survey questions and therefore could only be evaluated if individuals singled them out for comments in open-ended questions. The Pre-Action Analysis, Commander's Timeout, and Team Decision-Making Debrief were addressed explicitly in the survey. However, they were not used consistently during the TDXs for a variety of reasons, including exercise time constraints and lack of discrete start and end points for the TDXs, as conducted. Additionally, several participants and O/Cs pointed out that the Squadron Commander already had a method for sharing his situational awareness and intent, and for preparing and debriefing the staff.

The discussion below is based on the data and comments that were related to the Team Training Sessions and should be examined within the limitations outlined above. These data were collected at the end of TDX 1, at the end of TDX 3 (encompassing both TDX 2 and TDX 3), at the end of TDX 4 (the end of the training week), and at the end of the BCR III (Day 15). Training evaluations from the participants and especially the Squadron Commander are also mentioned where appropriate and informative.

<u>Information management</u>. The only data that were collected about the information management session were in the form of comments on the surveys and interviews. Comments from several participants suggested that the information management session was not the best use of their time during the train-up week, because the material presented had been covered in other training or was just a part of their everyday way of doing business. However, comments following the later TDXs reflected that the unit was still dealing with information management issues ("too much information," "information overload," "still need to work through prioritization and dissemination"). One node commander indicated that his difficulty knowing what the commander wanted at times was normal (although it should be noted that "normal" is not the same as "inevitable"). These comments reflect a need for information management training, and suggest that the training should address the issues that arise with Battle Command using C^4I systems (for example, at the level of file management, overlay management, dissemination, and manipulation). Other comments reflected the perception that the information management session was aimed solely at the primary training audience and ignored the extended training audience.

On reflection, this session appeared at the wrong time in the training. It was presented when most of the trainees were still thinking about individual procedural skills, before the TDXs. Only after they began work as a multi-node staff did the information management problems surface. Presenting the training prior to their having any experience with the difficulties of dealing with a heavy information load did not allow them to relate the training content to personal experience. Although some of the negative comments about this session came from the more senior officers, others in the unit found the information management issues to be challenging in the TDXs. This session may be more useful when some information management tasks are about to be performed, by addressing file management and management of transferred whiteboards, overlays and files.

Another shortcoming in this training was the use of e-mail as the basis for a short group exercise for the primary training audience, since e-mail was rarely used in the BCR environment. Most communication was conducted over voice/radio and via the downloading and sending of files through the network. These examples would have been more relevant for the training, especially if the training occurred later in the week.

Roles and functions. The roles and functions training session was not evaluated explicitly in the surveys; however, several training survey comments suggest that some people were not really sure what tasks they were supposed to be doing during the training (e.g., "I am finding it difficult to find my niche as effects guy… what do I do?" and, "streamline who delegates to me…"). Although unit personnel began to have questions about their role early in the training, the scheduling of the roles and functions session which called for the session to be conducted on the third day of training was appropriate since most soldiers would not have been exposed to enough of the capabilities of the SC^4 system prior to this point to understand what they were supposed to be doing or how their role or function could be modified to better support the commander.

Pre-action analysis, commander's timeout, and team decision-making debrief. A Pre-Action Analysis was conducted at the beginning of TDX 1; however, it was not fully implemented as designed. Subsequently, the Commander and Training Director chose not to conduct formal Pre-Action Analyses, although they did spend a few minutes at the start of each day discussing the tactical scenario for the upcoming TDX; thus the evaluations reflect a limited implementation of this technique. In addition, the Commander's Timeout was never utilized in the intended manner, where the Squadron Commander would give his situational awareness and elicit reactions and other viewpoints from the rest of the staff and company commanders. Instead, the Squadron Commander either called a huddle for his node OICs or his company commanders, but did not call a time-out for all the staff and company commanders nor ask for others' interpretations of the situation.

Finally, the Team Decision Making Debrief was not implemented as intended. Due to the TDXs having no clear start and end events, as conducted, it was difficult to use distinct TDX boundaries as the cut-offs for discussing certain issues, and as a result, the debriefs focused on the day's events rather than specific TDX objectives. In general, these sessions reviewed processes to sustain and improve unit tactical performance and discussion of TTPs rather than decision-making processes, workload distribution, or situational awareness.

Table 10 presents the means for each instance participants rated these three sessions. The sessions were each rated on whether they were helpful and would be useful in future training (end of training and end of BCR III only). For all statement ratings, a "1" signified that the participant strongly disagreed with the statement, a "3" meant neither agree nor disagree, and a "5" signified that the participant strongly agreed with the statement. Standard deviations are presented in parentheses.

Table 10

Team Training Session Means

	Item					
	Pre-Action Analysis		Commander's Timeout		Team Decision-Making Debrief	
Phase	Helpful	Future	Helpful	Future	Helpful	Future
TDX 1	3.51[a] (0.78)	--	3.29[e] (0.82)	--	3.50[b] (0.79)	--
TDX 2 & 3	3.56[b] (0.66)	--	3.35[e] (0.61)	--	3.61[c] (0.97)	--
TDX 4	3.57[a] (0.65)	3.77[a] (0.73)	3.35[e] (0.71)	3.48[e] (0.77)	3.76[c] (0.66)	3.82[c] (0.73)
End of Training	--	3.69[d] (0.97)	--	3.41[d] (0.87)	--	3.69[d] (1.03)

Note. Scale values were 1=Strongly Disagree; 2=Disagree; 3=Neither Disagree nor Agree; 4=Agree; 5=Strongly Agree. [a]N=35; [b]N=34; [c]N=33; [d]N=32; [e]N=31. Dashes (--) indicate the question did not appear on that survey.

The modal response for all Pre-Action Analysis ratings was "4," which signifies that in general, respondents appeared to believe that this technique was helpful during the TDXs and would be something that they would find useful in future training. The extended training audience (company-level and below) found the Pre-Action Analysis sessions less useful than did the primary training audience. One respondent suggested that the session should be used to set critical objectives and focus problem-solving (as had been intended when the session was designed). In one interview, a node commander referred to the Pre-Action Analysis as "critical, but not used properly or effectively."

The modal response for the Commander's Timeout ratings was "3," which signifies that in general, respondents believed this technique was not helpful. Over the three days of TDXs, the Commander had two informal meetings with the node OICs and with the company commanders as an opportunity for these people to "recalibrate." These meetings did not include other members of the staff, and so did not serve as an opportunity for the other staff members to learn from the Commander's expertise in sizing up the situation. Because of this, the extended training audience in particular felt that the Commander's Timeout sessions were not helpful. Several participants commented that, in general, stepping aside with the Commander and reviewing his intent and his situational awareness is a vital activity for the staff. In interviews, there was a strong show of support for the training value of situational awareness timeouts, as required. In addition, when asked, the Commander stated that he understood the importance of his role in shaping other people's understanding of the situation by asking questions and probing for interpretation of events and information.

The modal response for all Team Decision-Making Debrief ratings was "4," which indicates that overall, participants thought it was useful. Several of the respondents commented that the debrief sessions were really just after action reviews (AARs). Although the AAR concept is appropriate for a focus on tactical issues and the content of tactical decisions, the intent for the debriefs was to focus the learning points on the team decision making *process*. A focus on shared situational awareness, information management, workload, and roles and functions in relation to decision-making could have been a valuable addition to the debrief sessions.

Summary of Training Method Findings

The results of the surveys, interviews, and observations described above provide information concerning both the structure and the content of the training. Structure includes the training flow, implementation model, training scenarios, and support materials. Even though the training was not conducted as designed, it appears that the progression from individual to small group to collective training is appropriate. Respondents who recognized the progression affirmed it; those who did not recognize it requested such a progression. In particular, they indicated that the orientation could have been more useful in preparing them for the train-up that followed.

The training sequence, involving a very short period of SC^4 system introduction (Level 2), followed by small group functional training outside the node structure (Level 3) and intra- and inter-node training (Level 4), requires some examination. The initial tools training did not contain enough formal instruction, practice, or skill assurance. As a result, during small group training, individuals were still attempting to learn individual skills. The Level 4 training which combined staff training with company commander and platoon leader training (multi-echelon) was frustrating for some participants at both the squadron and company levels.

The TDXs were seen as an important component of preparation. While the mission segments (planning, rehearsal, and execution) were acceptable, the scenarios may have been both too slow-paced and too deliberate. By incorporating more high-stress situations, the staff would have had more incentive to conduct situational awareness recalibrations and intensive decision-making debriefs. Some participants also suggested more TDXs so they would have had more opportunities to practice and refine their TTPs.

The support materials for the TDXs (e.g., INTSUMs and FRAGOs) were seen as adequate. The single item most conspicuous by its absence was communication of the training objectives to the participants. Since the overall training objectives were not covered as intended in the initial orientation, these objectives should have been more clearly stated as the training progressed. Revisions to the delivery of the training materials should include this simple but critical feature. Other suggestions pertaining to materials focused on training checklists for the RAs, job aids showing SC^4 operations, charts of BLUFOR and OPFOR systems and capabilities, and roadmaps of objectives and topics for the training week.

Results concerning the training content centered on SC^4 topics, battlefield environment information, and staff process training. In general, participants found their initial training to be only adequate in terms of what they learned about the SC^4 system. Suggested fixes ranged from

more time for structured practice, to better-trained RAs, to detailed job aids. In addition, inclusion of CSS functions was generally judged inadequate.

Reactions to the team training sessions were mixed. Most of the respondents indicated that this staff did not need information management training as provided, although there was no argument that it was an important topic. Nonetheless, they continued to have information management difficulties throughout the TDXs and into the trials. The timing of the training, coming as it did prior to any significant information flow, may have been the problem.

Likewise, most participants agreed that the Pre-Action Analysis, Commander's Timeout, and Team Decision-Making Debrief were valuable in concept but not particularly useful as implemented. Whether this is due to the way in which they were conducted, or to the way they were designed is unknown. However, it appears that the concepts should be considered for future use.

Performance Evaluation Methods

The performance data collection effort was designed to gain experience with acquiring various sources of information, especially digital information from the SC^4 system, to enhance performance feedback to future battle staffs. The main purpose of this section is to examine how well the various evaluation methods (automated measures, surveys, interviews and observation) used during the BCR III functioned so that they can be improved for future research efforts. Performance data collection during the BCR III was not designed to evaluate the performance of the unit since there were no doctrinal or baseline standards on which to base performance measures and BCR III conditions did not permit pre- and post-training performance measurements of the unit. However, sample results from the performance data that were collected are presented in this section. Complete BCR III data summaries obtained by the project team are presented in Training and Measurement Support Package Volume 5 (1999). In addition, the project team's analysis of the data was provided to the MMBL for potential inclusion in the BCR III BLEFR (1999).

Sample Result - Assist in Decision-Making Process

Automated measures, surveys, interviews, and observations were used to obtain data pertaining to the ability of the SC^4 system to support the Commander's decision-making process. This capability was amply demonstrated through a variety of automated measures that looked at different aspects of the SC^4 system. A major contributor to the ability of the commander to make decisions was the performance of the UAVs which were controlled by the squadron, and micro-UAVs which were controlled by the squadron scout platoon. Over the course of the trials, these two systems first detected 51% of all OPFOR vehicles in the squadron's area of interest which extended 15 kilometers beyond the squadron's area of responsibility (delineated by its rear, flank, and forward boundaries assigned by its higher headquarters). In a further breakdown, the two systems detected 32% of tanks, 53% of infantry fighting vehicles (IFV), and 56% of artillery vehicles. When all types of sensors were included, the squadron was able to detect 70% of OPFOR vehicles. Interestingly, the majority of these vehicles (64%) were first detected in the area of interest, beyond the area of operations, which gave the squadron ample time to assess OPFOR strength, capabilities, and intentions before they closed to within range of the squadron's

combat systems. For the 30% of OPFOR vehicles not detected, the majority were second echelon tanks or artillery systems. None of these systems had an impact on the outcome of any mission.

The common picture of the tactical situation that the SC^4 system was automatically providing to the squadron was reflected in the type and apparently low amount of squadron internal communications (see Figure 6). Overall, the amount of time that was spent by soldiers communicating with one another using the SC^4 communications tools was very low. The amount of intercom usage is lower than had been expected perhaps because the ambient noise in the BCR III site was low and it was possible for soldiers within the nodes to converse with one another without using the intercom system. The e-mail tool was rarely used during BCR III.

Another impact of very good situational awareness was the usage rate for various PVD tools. With 70% of the OPFOR vehicles detected by the squadron, many PVD tools were used minimally or not used at all. Among all members of the total training audience, the overlay editor tool was used by 31 soldiers, the overlay file management tool was used by 11 soldiers, and the alert tool was used by only 7 soldiers. Additional research is needed to determine why the forward line of own troops (FLOT) display, field of view (FOV) display, plan tool, snail display, stealth control, and find tools were used minimally or not at all during the trials.

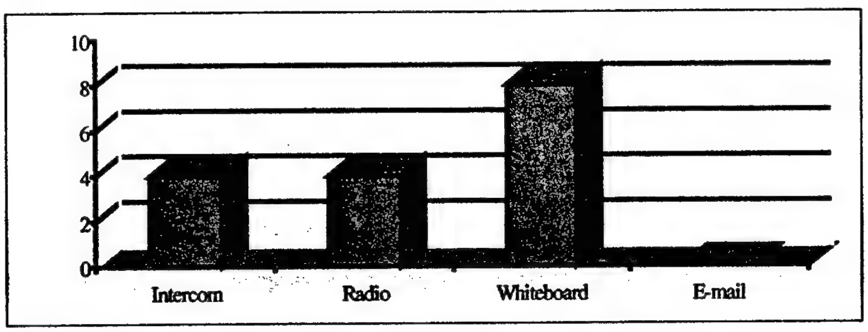
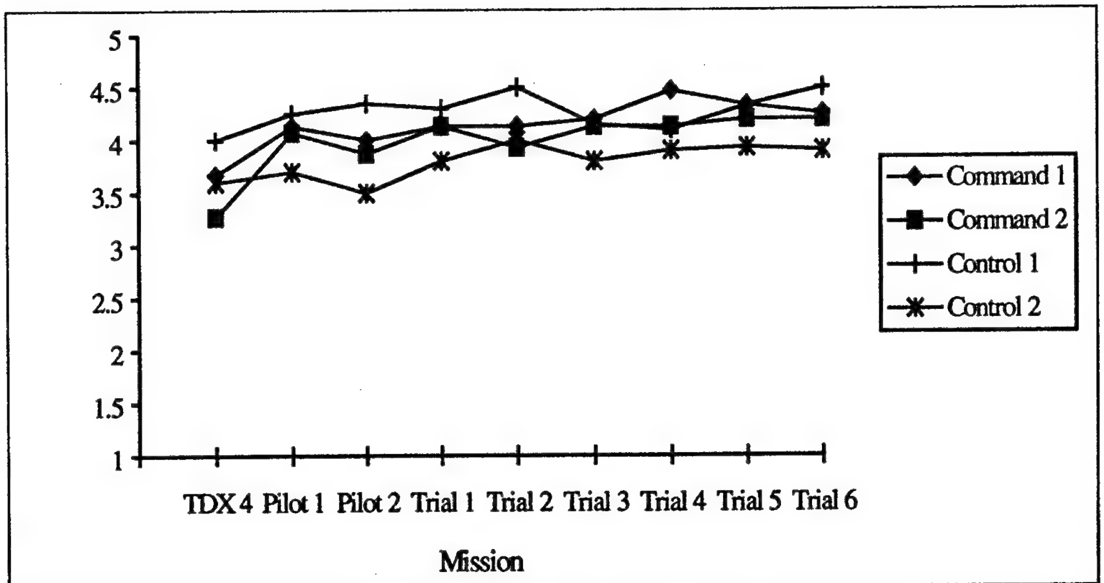


Figure 6. Percent of time individual communication systems used.

The survey that most directly addressed support of decision-making was the Operations Planning survey. Statements on the survey, which were rated on a 5-point scale ("1" = strongly disagree, "5" = strongly agree), were divided into three main factors: understanding information requirements (questions 6-10), understanding intent during mission planning (questions 1, 2, and 5), and understanding roles and functions (questions 3, 4, and 11). The means for these factors were examined by day for each node. As can be seen in Figure 7, the nodes rated themselves higher on understanding information requirements at the end of the BCR III than they did during training. The same thing occurred to a similar degree with respect to understanding intent (see Figure 8) and roles and functions (see Figure 9).

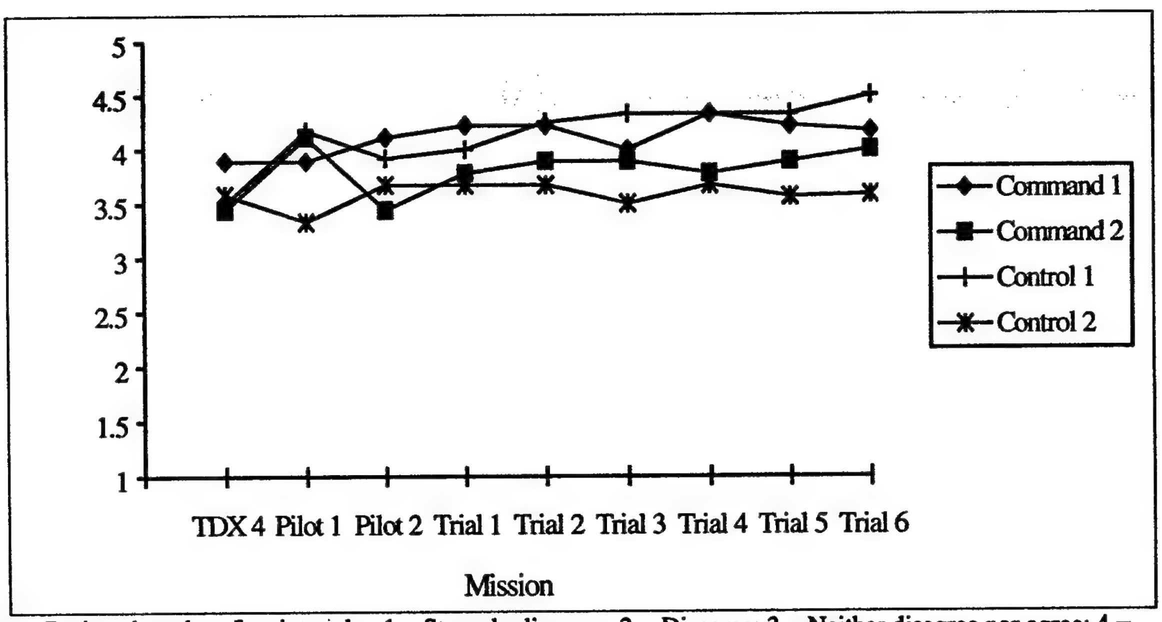
Although the nodes report slight improvements in these three areas by the end of the last mission, the scale used may not provide enough room for improvement. A 7-point scale may have shown more improvement from one mission to the next. Another explanation is that by the end of TDX 4, the participants understood what their commander expected from them. If the training provided them enough practice for what they were doing during the missions, it would



Note. Ratings based on 5-point scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither disagree nor agree; 4 = Agree; 5 = Strongly agree.

Figure 7. Information management understanding by node.

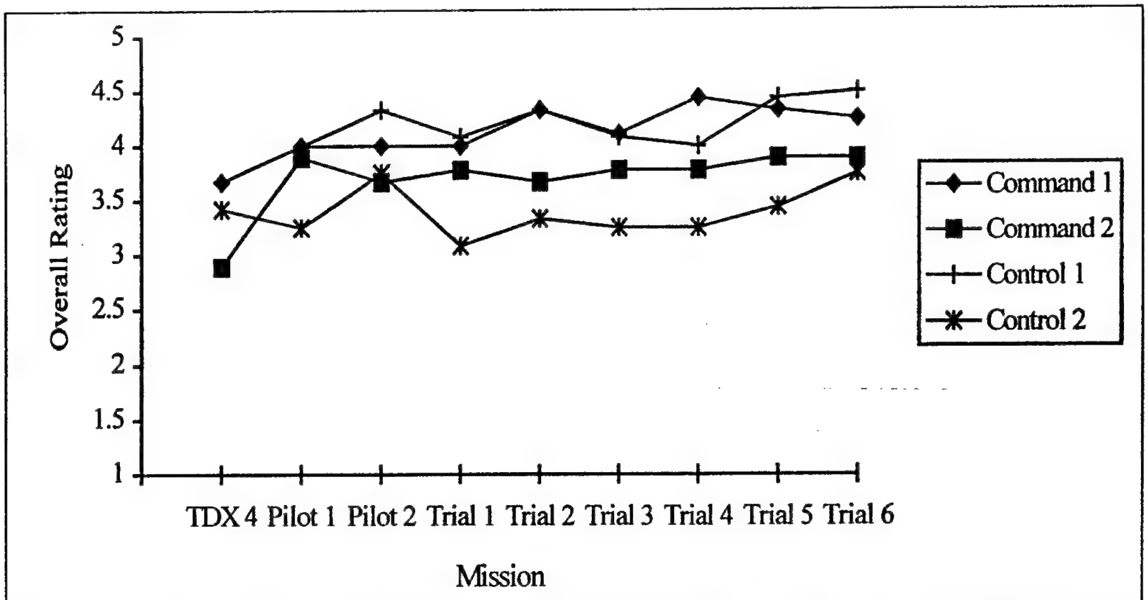
not be expected that their perceptions of understanding would improve much if they were already operating at a high level. It may be that an improved form of this scale is required to better measure the staff's ability to assist the Commander's decision-making process with the reengineered Battle Command.



Note. Ratings based on 5-point scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither disagree nor agree; 4 = Agree; 5 = Strongly agree.

Figure 8. Understanding intent by node.

In the opinion of most soldier participants in the exercise, the SC4 system provided most, except for CSS-related statuses, of the information needed to assist the commander's decision-making process. The Squadron Commander thought he had sufficient information except during those periods when UAVs were not available to him. Additionally, he thought that his unit was not fully exploiting the capabilities of the system since they were still learning how to use it.



Note. Ratings based on 5-point scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither disagree nor agree; 4 = Agree; 5 = Strongly agree.

Figure 9. Understanding roles and functions by node.

The observers confirmed the SC4 system was providing almost 100% situational awareness to the commander and his staff. They also noted that the battle damage reports they were receiving were very timely and accurate. By combining the automated data measurement, survey results, interviews, and observer comments, a full picture of the capability of the SC4 system to support decision-making was developed.

Sample Result - Team Performance and Processes

To study the impacts of the reengineered battle command on team performance, survey data, observations, and interviews were used. In the first part of the Organizational Awareness survey, participants were asked to rate on a 5-point scale ("1" = strongly disagree, "5" = strongly agree) whether each position in the node was performing the tasks the rater expected that position to perform. Overall, everyone felt that positions were performing the tasks they were expected to perform, with means ranging from 3.98 to 4.14. In addition, participants were asked to rate whether each node was performing the tasks the rater expected that node to perform. Again, ratings were fairly high and consistent, with overall ratings ranging from 3.98 to 4.28. These ratings indicate that the staff felt reasonably confident about their expectations about who was doing what.

In response to this issue, data were also collected on certain behaviors by a group of observers using laptops. Data were collected on six types of behaviors: backup, communication, coordination, monitoring, team orientation, and overall. In order to reduce bias, observers rotated nodes after every mission. The mean ratings can be seen in Table 11.

The results suggest that the command nodes were operating at a high level of team performance. The control nodes, however, were mediocre. This may be due to a lack of workload in the nodes, failure to proactively do their jobs, or failure to coordinate internally. If they did not have enough work that required teamwork, then they could not have worked on their teamwork skills. Teamwork processes may be measured more accurately if the nodes are under more pressure and need to use their teamwork skills in order to accomplish their goals.

Table 11

Ratings of Behavior Types for Each Node

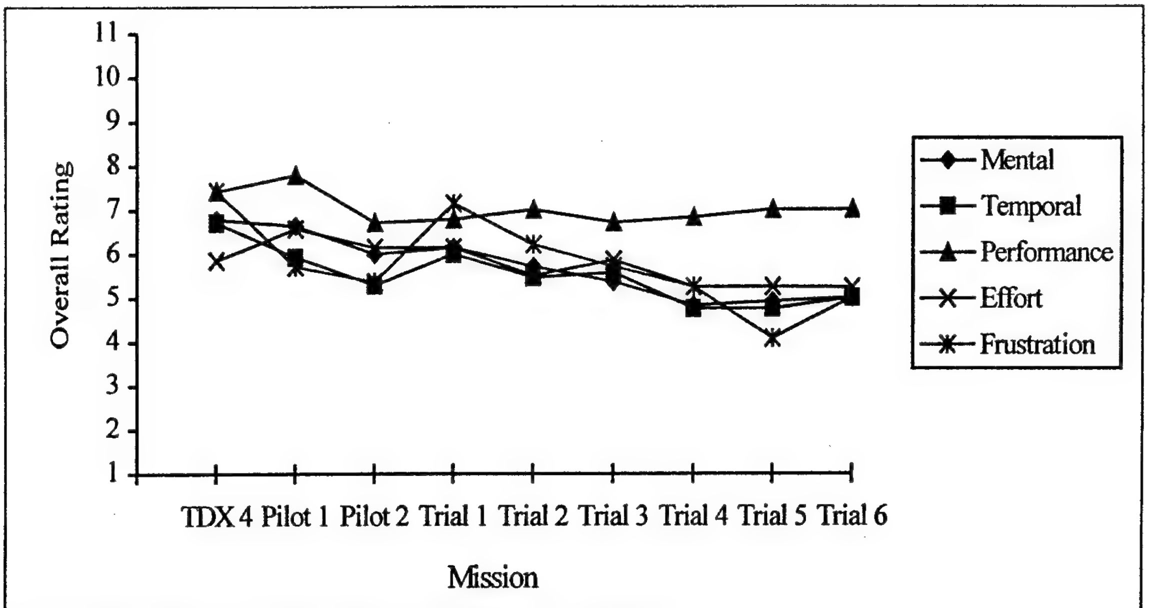
Behavior	Node			
	Command 1	Command 2	Control 1	Control 2
Backup	4.25	4.90	2.32	1.80
Communication	5.19	5.45	2.96	2.35
Coordination	4.67	5.33	2.64	2.61
Monitoring	4.88	5.30	2.57	2.19
Team Orientation	4.88	5.30	2.69	3.00
Overall	5.17	5.10	2.75	3.29

Note. Ratings based on 7-point scale, 1 = very poor performance; 7 = excellent performance.

In the interviews, several soldiers made the recommendation that the squadron nodes needed to be reconfigured. The most common observation was that the Control 1 node function should be changed to control all of the reconnaissance assets within the squadron. Several soldiers thought that the squadron intelligence officer should be positioned in the Control 2 node. The Squadron Commander thought that a staff configured into geographically separated nodes would decrease the overall performance of the staff due to the feeling of isolation among the staff members.

Sample Result - Impacts on Perceived and Actual Workload

In order to address this issue, the Individual and Team Workload survey was used. First, participants rated their own individual workload. Next they rated the workload of each node. Finally, they rated the workload for the entire staff. When rating their own workload, there was no consistent pattern. However, there was a general downward trend. Mental demand, temporal demand, effort, and frustration decreased as the BCR III progressed; performance, however, remained at a constant level. Figure 10 shows this general trend for all nodes. This result indicates that participants felt they could achieve the same level of performance with less effort the more familiar they became with the reengineered battle command concept and demands.



Note. Ratings based on 11-point scale, 1 = very low; 11 = very high.

Figure 10. Perceived individual workload.

After rating their own workload, participants were asked to rate the overall workload for each node. Again, ratings fluctuated depending on the activities they engaged in on that particular day. In general, all nodes rated everyone's workload as decreasing over time, except Command 2, which rated Control 1 and 2's workloads as decreasing and Command 1 and 2's workloads as staying consistent over time. Table 12 shows the means for each node collapsed across days.

As can be seen in the table, most nodes rated their own workloads somewhere in the middle. Control 1 rated themselves as higher than the other nodes rated it. In addition, Control 1 gave the highest ratings of workload for all the nodes. This suggests that Control 1 may not have had a good grasp of the overall workload, and of what the other nodes were doing. The other nodes seem to have a fairly good idea of how much work is going on in the other nodes. This is important, because if the nodes are aware of the workload of others, they can make better judgments on when someone is overloaded and may need help.

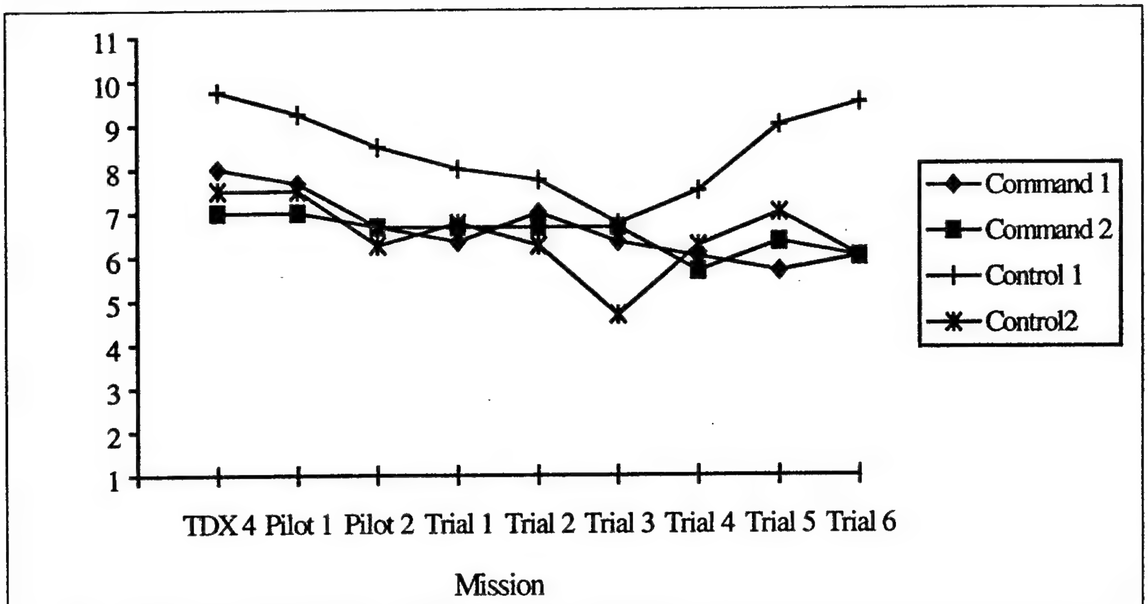
Table 12

Perceived Workload of Nodes

Rated By	Rating			
	Command 1	Command 2	Control 1	Control 2
Command 1	**5.96**	6.82	5.75	7.43
Command 2	5.59	**7.22**	6.22	6.30
Control 1	8.74	8.42	**7.58**	7.84
Control 2	7.40	7.50	4.79	**6.51**

Note. Ratings in bold are self-ratings. Ratings based on 11-point scale, 1 = very low; 11 = very high.

Finally, participants were asked to evaluate the workload of the entire staff. Figure 11 shows the ratings across days by each node. As can be seen in the figure, the ratings of overall workload generally decrease over time. Only Control 1 rates workload as increasing toward the end of the BCR III. Interestingly, except for Control 1, all the nodes rate the level of overall workload on the last mission as equal (6.00). This indicates that the other three nodes have a common understanding of their workload.



Note. Ratings based on 11-point scale, 1 = very low; 11 = very high.

Figure 11. Perceived workload of entire staff.

Summary of Performance Evaluation Findings

The sample results presented above provide an idea of the way the different measures were used to study staff performance. For most of the performance issues, more than one method was used to provide corroboration of the results obtained. Although the four methods provided the expected results, some improvements can be made for future research. Below is a summation of each evaluation method.

Automated measurement. The data collected from the MMBL DCA were cumbersome to use. Specific data points had been requested prior to the start of the BCR III, but were not programmed until the end. Additional data collection formats had to be designed in order for the data to be pulled from the system. Once the data were obtained, they were presented along with vast numbers of other data points, so that considerable data examination, editing, and subsequent analyses were required. Once the data had been analyzed, useful results were obtained. An example of an automated measure analysis is presented in Appendix F. As noted previously, lack of immediate BCR III data analyses prevented them from being used to provide performance feedback to the training unit.

Surveys. Surveys, as a measurement method, were easy to implement although participants complained about the writing chore. The particular surveys used in this effort

should not necessarily be kept for future research. Instead, surveys that provide outcome and process data that can be more clearly linked to training evaluation and battle staff performance should be developed and tested in future research. However, surveys will not be appropriate for obtaining information for performance feedback unless a) a method for quick turnaround of results is found; and b) front-end analysis indicates that survey data can address questions about the unit's performance.

Interviews. Interviews enabled the gathering of information and impressions far beyond what was obtained in surveys, observations, and automated means during BCR III. Given the current difficulties in obtaining and using automated data, a great deal more information could have been collected on battle staff performance by means of interviews. Like surveys, interviews were not useful for immediate performance feedback purposes.

Observation. The laptop-assisted measurement method was found to be easy to use, and the data capture was suitable for subsequent analysis. The observers using the ODCI recommended adding more space for observer notes and modifying the observation categories. This second point in particular is important, relating to the previous comments on front-end analysis. Although the observation categories seemed likely candidates as sources of information about team performance, they were less useful in operation than had been anticipated. With additional enhancements to the ODCI system that would allow for real-time transmission of observations to a central processing site, observations could be a valuable input to performance feedback sessions.

Lessons Learned for Future Research

As a research and development effort, this project has as a major product the documentation of lessons learned. These lessons are addressed to several audiences, including developers of future staff training and researchers conducting advanced C^4I systems experiments. The lessons fall into four categories[3]:

- Training design
- Team training sessions
- Training support materials
- Evaluation methods

The lessons learned are divided into two sections: 1) those that are specific to the pilot implementation of the prototype staff training and evaluation package; and 2) those that are applicable to the general development of training and evaluation programs.

[3] In addition to the observations and results documented in the previous section, lessons learned on the experiment design, support personnel preparation, documentation of TTPs, battalion-level staff organizations, and design modifications for the SC^4 system itself were provided to ARI as a Memorandum for Record (6 July 1999).

Pilot Implementation Lessons Learned

The lessons learned from the pilot implementation of the prototype training and evaluation package are summarized in Table 13. A detailed discussion of each lesson follows the table.

Table 13

Summary of Pilot Implementation Lessons Learned

Training Design

Revise initial orientation.
Eliminate movement and clustering of training participants during function training.
Decrease time for initial orientation.
Increase fundamental training time.
Increase task training.
Decrease time for TDXs.
Integrate extended training audience into all training.

Team Training Sessions

Revise information management training session.
Revise title of training sessions to reflect current Army terminology.

Training Support Materials

Complete existing prototype training package.
Develop unit preparation plan.
Develop train-the-trainer materials for team training sessions.
Develop train-the-trainer materials for site trainers.

Evaluation Methods

Continue the design and development of automated measures.
Continue development of ODCI.
Continue research on survey measures for staffs.

Training Design

The prototype staff training package was designed as a hierarchical progression from an initial orientation through individual and small group training to collective training including team training sessions. It incorporated aspects recommended in the training literature, including an advance organizer, a realistic underlying context, and both formal instruction and hands-on practice opportunities that were based on the principles of training vignettes developed in previous ARI sponsored training research and development. All of these aspects should be retained. However, additional refinement of the training design is needed in three areas: organization, time allocation, and training audience.

Organization. The training was structured to progress through five levels. The participants concurred with the structured progression and thought the building block training sequence was effective. They also agreed with the concept that function-based instruction assisted them in the development of SC^4 system skills. Detracting from this overall positive assessment was the statement from many participants that they never understood the goal or the performance standard for each training level or how the training levels were interrelated until the training was completed.

To address this shortcoming, the initial orientation needs to be revised to clearly establish that there is progressivity to the training and to identify individual and team tasks, with their associated standards that participants are required to master. To reinforce the standards, the prototype training package also needs to incorporate SC^4 tool skill tests that are embedded in the system. Evaluated functional test exercises for both individuals and teams within the staff need to be developed, as well. Participants should be given performance feedback and any required remedial training for the level of training they have completed before they progress to the next level.

Another specific concern for the training participants was the consolidation of participants by role during function training (Level 3) which was identified as a training detractor. The intent was to have those participants who perform the same function in different nodes be given an opportunity to develop a shared understanding of how to exploit the capabilities of the SC^4 system and to develop SOPs and TTPs among themselves. The need for this type of training was predicated on a model in which an SC^4 equipped, geographically dispersed staff would distribute its products or processes among individuals located in different nodes. The unit staff undergoing the training in the pilot implementation of the prototype training package did not distribute their workload in this fashion. Each node was responsible for a product and rarely did individuals in different nodes collaboratively work on a product. The shifting of participants between nodes created confusion and may have impeded the development of intra-node roles and functions. Thus, the potential value of having participants performing the same function sharing a common training experience was negated.

To address this problem, the analysis of staff processes needs to be refined to reflect two modes for staff operations: 1) staff product and/or process responsibilities will be assigned to specific nodes or, 2) the workload will be distributed across various nodes. In either case, physically moving training audience members around a complex training site should be avoided. If the refined analysis supports continuing collaborative training across nodes for a particular staff process, then structured practice exercises should be developed to allow participants to participate in collaborative training while operating from their assigned node.

Time Allocation. The participants indicated that the 5-day period allocated for training was sufficient, but the time for classroom orientation and instruction should be limited in favor of additional practical exercises on the system. Though collective task training utilized the majority of the time allocated for training, the time provided was still insufficient to achieve all training objectives. The key is to balance the time required to teach individuals new equipment skills with the time allocated to develop techniques and procedures that integrate these skills into

the required staff functions and processes. Training on new systems must include generous amounts of time for hands-on practice and exploration.

The participants stated that the time allocated for Level 1 training (Initial Orientation) was too long for the information provided. Much of the information presented was at too high a level for participants. Additional comments revealed that the time devoted to multi-media and slide based classroom training on the SC^4 system would be better utilized for practice on the system. The schedule provided three hours for the orientation, but an hour would be sufficient. The other two hours should be added to fundamentals (Level 2) training for additional practice exercises.

The time allocated for functions (Level 3) training seemed sufficient, but the participants indicated that the four hours allocated for task training (Level 4) seemed insufficient. Observers concurred with this assessment. They noted that task training, which uses both team training sessions to train higher cognitive skills and simulation based exercises to develop inter-node roles, battle staff TTPs, and SOPs, requires the most time. The first team training session, Information Management, used over 90 minutes. Practicing the tasks associated with the Level 4 structured exercises, such as establishing a whiteboard conference, diverted more time from the stated training objective which was to prepare to participate in the TDXs. More time is required for the participants to fully explore their roles and functions and achieve the task training objective. Level 4 should be expanded to 12 hours. This increase in time allows full implementation of the team training sessions.

The participants observed that the overall pace of the TDXs (Level 5) was slow. This was due, in part, to the failure of some of training participants to achieve all of the objectives during system task training. This limited their ability to develop detailed techniques and procedures associated with Level 4 roles and functions. Observations from the project team indicate that reducing Level 5 to 16 hours by transferring eight hours to Level 4 would not adversely affect the quality of the Level 5 training.

Training Audience. Although the prototype staff training package was designed for the primary battalion-level staff of 14 soldiers, another 21 soldiers were required to support some aspects of the staff training. These soldiers also needed to be trained on the operation of the SC^4 system. In previous ARI structured training projects, the training for the primary participants and other personnel required to support the primary participants was conducted along separate time lines. However this project required the supporting participants, at the company and platoon levels, be trained on the same timeline. Additionally, the supporting participants were required to interface with the primary participants for specific tasks during the training prototype. Many of the 21 soldiers in the extended training audience thought that they were inadequately trained or were given insufficient opportunities to execute challenging operations using the SC^4 system during the training week.

More clearly defined roles and responsibilities for supporting participants need to be incorporated into the prototype training package. All training activities need to include both the extended training audience as well as the primary audience. Training standards for the extended audience also need to be developed.

Team Training Sessions

Staff training on team processes such as decision-making, shared mental models, roles and functions, situational awareness, and information management was one of the primary emphases of the project. The pilot implementation of the prototype training package provided the project team with an opportunity to trial five specific team training sessions: Information Management, Roles and Functions, Pre-Action Analysis, Commander's Timeout, and Tactical Decision-Making Debrief. Comments received from the training audience members indicate that the content of the sessions had potential for being useful, and that sessions conducted as part of collective training exercises would be valuable.

The Information Management Session, which was identified by the training participants as the least useful training session, needs further research and development both as to its content and the conditions under which it is presented to a training audience. Examples used during the sessions need to be tailored specifically to the C^4I system used by the staff. Researchers should also determine if revising the titles of the Pre-Action Analysis, Commander's Timeout, Roles and Functions, and Team Decision-making Debrief training sessions to reflect contemporary Army terminology might facilitate wider acceptance of these innovative training sessions.

Training Support Materials

The training materials used for the pilot implementation of the prototype training package constituted only part of a full-blown training support package, as defined in U.S. Army Training and Doctrine Command (TRADOC) Regulation 350-70 (DA, 1999). The scenario tactical materials, simulation files, OPFOR guides, and administrative instructions were included. Only partial train-the-trainer materials for the initial system train-up and TDXs were included. No materials for the training audience were prepared. All of the information for the training audience was provided either through RA-delivered instruction or briefings by the Training Director. Because there were no training audience materials and only partial train-the-trainer materials, the information presented to the training audience was perceived (rightly) as incomplete and inconsistent. Additional development of the existing prototype training package material such as the training plan outlines and practice exercises is required before its next use. Based on the result of the pilot implementation, additional material, such as that described below, needs to be developed for the training package as well.

Unit Preparation Plan. A plan needs to be developed to assist the unit to take advantage of the available train-up time. As in the BCR III, a short briefing for the full training audience should be provided at least four weeks prior to the training. At that time, the training audience members should be told the objectives, the basic schedule, and the activities that will take place during training and the experiment. They should be told what they should have accomplished before they arrive for the train-up, and given printed or CD-ROM materials illustrating or guiding the preparation. Topics suitable for preparation include unit SOPs, techniques and procedures learned from previous training and operations (with the caution that they will likely develop more techniques and procedures specifically to their unit), and descriptions of team skills that they can begin to develop or think about. While an overview of the C^4I system and its capabilities would be useful, the unit should not be expected to get familiar with the system prior to arriving at the site unless they have access to the system or to a simulation of the system.

Developers of this preparation plan need to be sensitive to other competing requirements the unit may have as it prepares for the C^4I system training. Unit requirements should be minimal, require little or no resources, and be easily mastered. Appropriate multi-media material that may be used by individuals outside of their normal duty place and time should also be explored as an option for assisting the unit in preparing for the training.

Team Training Session Trainer Materials. These train-the-trainer materials need to be developed. A model for the contents would include an overview, guidelines for the facilitator, detailed descriptions of the sessions, practice exercises for each type of session, and guidelines for providing feedback to the participants. A key component of the train-the-trainer material should be a description of the value of the team training sessions and how they differ from training that is currently being done for staffs.

Training Site Personnel Materials. These train-the-trainer materials need to be developed for the personnel designated to implement the prototype training package beyond the material that was developed and incorporated into the training package for the Training Director. This material should include an overview of the prototype training package, a detailed description of the trainer's responsibilities, structured practice exercises, and proficiency test materials. In addition, access to the operator's manual for the C^4I system should be readily available.

Evaluation Methods

Considerable research remains to be done on developing both performance standards and evaluation methods for future battle staffs operating advanced C^4I systems. While surveys, observations, and interviews were used to gather data during the pilot implementation, the project team made an effort to develop automated measures that could take advantage of the analytical power and processing speed of advanced C^4I systems to provide real or near real-time feedback to the training participants. This effort, as described earlier, was only partially successful. Several lessons learned during this project may be of value to other researchers.

Specifying the format in which the automated measures data is to be reported will aid the programmer extracting data from the C^4I system and simplify readying the data for staff performance feedback sessions. The DCA system used during this project provides the programmer with a multitude of methods to manipulate and format data. Working with both the operational definition of an automated measure and the specific format in which it is to be reported, the programmer will be better able to meet the expectations of the training evaluator.

Development of the ODCI based on laptop computer technology or personal data assistant technology should continue. Strategies to deal with unexpected events or with planned events that did not occur should be created. The ODCI systems should be linked through networks so that automated processing and analysis of data can occur simultaneously with observation recording so that, like the automated measurements, feedback can be provided to the staff immediately after the completion of their training.

More research is required to locate better measures of staff processes that are appropriate for use during surveys than were used during this project. If these measures do not exist, then

they should be developed and subjected to extensive testing to determine their validity and reliability.

General Lessons Learned

Table 14 summarizes the lessons learned during this project that may apply to other training design and development efforts related to advanced C^4I systems and future staffs. A discussion of each lesson learned follows.

Table 14

Summary of General Lessons Learned

Training Design
Determine if TDXs and Team Training Sessions should be part of system training.
Explore self-guided individual systems training.
Team Training Sessions
Develop strategy to increase unit leadership acceptance of team training sessions.
Incorporate a facilitator from outside of the unit to implement these sessions.
Develop formal team training feedback sessions.
Training Support Materials
Develop job aids for participants.
Evaluation Methods
Research appropriate relationship between outcome measures and performance measures.
Expand automated measures.
Develop method to capture emerging TTPs and tactical standing operating procedures (TACSOPs) during training.

Training Design

In designing training for a future staff, two different, but interrelated, techniques (TDXs and team training sessions) were employed to focus on improving staff metacognitive skills, particularly those involved with supporting the commander's decision-making. During the trial implementation of the prototype training package, the challenges and stresses associated with learning the new organization, equipment, tactics, and C^4I system diminished the metacognitive aspect of the TDXs which became strictly system practice training exercises. The team training sessions were completely subsumed by other considerations.

An analysis is required to determine if this type of training should be done in conjunction with learning to function as a reorganized staff, geographically dispersed into small teams, operating an advanced C^4I system to control units and weapons systems that may exist in the future. Researchers should look to implementing these sessions in a less demanding systems training environment so that the benefits of incorporating them into staff training (which are

described in the theoretical literature and which were recognized by some of the training participants) can be fully realized.

In a time constrained environment where training participants are required to learn complex procedures to operate an evolving C^4I system with minimal documentation, detailed training and evaluation activities need to be performance-based, not time-based. After determining the minimum individual system skills needed by the participants to be able to operate effectively, the C^4I system training program needs to be as flexible and open-ended as possible. It should be self-guided with performance standards and evaluation activities incorporated into the training at frequent intervals. By placing greater emphasis on the participant's acquiring basic system skills early in the training program, the overall unit training program can be enhanced. Requiring participants to engage in a collective activity or practice exercise for which they are inadequately trained wastes considerable time retraining them and holds up the entire unit. Conversely, participants who have mastered a skill should be able to proceed to the next task when they are ready. If they have completed the training program in advance of the rest of their unit, they can use the time for additional practice or to explore other system capabilities.

Team Training Sessions

Implementing the team training sessions requires the cooperation and support of the unit leadership, particularly the battalion commander. This individual is the single most important influence on the success of a training program. An innovative training strategy, such as the team training sessions, requires that the leader is educated in advance as to the purpose and processes involved with the training, and is persuaded to wholeheartedly support it. The commander's cooperation and support are dependent upon the quality and perceived utility of the training, and the training support provided by the training director.

Closely associated with the concept of unit leadership acceptance of the training program is the method by which the training program is facilitated within the unit. The prototype training program was designed to be initially implemented by the training director, and transitioned to the battalion commander as the primary staff trainer. The design also required the commander to be a key participant in the training. This design should be reviewed for change or refinement. A better way to implement the team training sessions might be to have a trainer from outside of the unit, such as a higher headquarters commander, an experienced peer battalion commander, or a trained Senior O/C equivalent in rank and experience to the battalion commander, to facilitate these sessions. This individual needs the authority, gained by subject matter expertise and credibility, and supporting training materials to lead such sessions after completing a train-the-trainer course on team training sessions. Researchers should also consider implementing team training techniques into Army professional development courses.

Another lesson learned is that team training sessions need to have formal performance feedback sessions incorporated into them. Even if the sessions provide structured practice exercises, merely providing answers to the exercises is insufficient. In a complex organization facing challenging problems, there is usually more than one way to solve a problem. By using a facilitator to guide these feedback sessions, the training participants are exposed to ways to improve their performance beyond just being provided the right answer to a problem. The

facilitator, with subject matter expertise backed by experience, can suggest other ways of solving the problem and provide examples to guide the staff in improving their performance. Such feedback sessions can also foster among the participants an appreciation that their team's overall efficiency and coordination is improving. The feedback sessions also provide a method by which developers can assess the efficacy of particular training interventions and make improvements without having to directly involve the training participants in the measurement.

Training Support Materials

Job aids should be a primary development effort for any training program involving a complex, advanced C^4I system. These should be developed for training participants to portray the locations of system functions, enemy and friendly forces capabilities, training objectives, node responsibilities, and other information to which participants need to refer. As doctrine and TTPs are developed for future staff process experimentation, they should be provided as ready references to training participants until they are incorporated into standard Army doctrinal materials.

Evaluation Methods

The first lesson is that staff performance standards developers, and by extension, evaluation method developers need to decide whether the unit outcome of the staff action or the processes of the staff should be the focus. If the staff process is the focus, then a detailed analysis of the processes, which includes as a minimum the description of the process itself, who is involved, what tools are used, and what products are generated is required before evaluation measures and methods can be developed. Even if unit outcome measures will not be the primary tool to provide staff performance feedback, they are generally easier to develop than process measures. Consequently, they should always be used to supplement or back up staff process measures.

Automated measurement of staff performance continues to have unrealized potential. Additional research is required to determine which advanced digital C^4I system information can be used to measure staff processes rather than just outcomes. This information should then be directly importable, without additional analysis or reformatting, into real or near real-time staff performance feedback sessions.

A method to document emerging TTPs and TACSOPs needs to be developed prior to implementing prototype training for future staffs, especially in those instances where doctrine and staff processes have not yet been established. These TTPs and TACSOPs can be used by the Army doctrine community to refine the future staff's organization, equipment, and operational doctrine.

Summary and Conclusions

The prototype staff training and evaluation package developed during this project uses TDXs and team training sessions based on cognitive decision-making theory to train staff processes important in the information age. These training techniques were implemented during the Concept Experimentation Program BCR III Experiment conducted by the MMBL. The BCR

III provided a unique opportunity to implement this prototype training package since the organization, weapons, equipment, and C^4I system used by the training audience were conceptual models of what might be used by the Army in 10-15 years.

The prototype's topics, structure, evaluation plan, and methodology for development are grounded in the research literature. Development of the prototype training and evaluation package followed a tried and proven procedure laid out by TRADOC and previous ARI projects. Formative evaluation during the BCR III provided valuable insights upon which to base revisions to the design, team training sessions, training support materials, and evaluation methods. The revised research products associated with the prototype training package for the pilot implementation are documented in the five-volume set of materials entitled *Training and Measurement Support Package, Battle Command Reengineering III, Mounted Maneuver Battlespace Lab* (Mounted Maneuver Battlespace Lab, 1999c). Researchers interested in these volumes can access them through the Fort Knox MMBL. Additional trials of the prototype training and evaluation package are required to validate its efficacy and utility.

Continued development of the team training sessions is essential to exploit the technological advances in information processing and presentation represented by the SC^4 system employed during this project. There are two parallel phases to this development effort. The first phase is related to developing C^4I system expertise. This is primarily individual training, done either in professional development courses or through on-the-job training within the unit. The individual staff member, by virtue of his or her assignment selection, is tactically and technically qualified in terms of knowledge and skills for the position however, he or she may not be an expert with the particular C^4I system used by the staff. The unit C^4I system training needs to develop or maintain expertise within the staff member.

The second phase in developing C^4I system expertise is learning how to function as a staff consisting of teams of teams. While professional development schools can provide a foundation for team training, it is the unit commander's responsibility to train his staff. Unfortunately, there are few resources currently available to assist the commander in assessing his staff's training, especially in a staff equipped with emerging advanced C^4I systems (Brown, 1999). Research priority should be given to developing the tools, especially embedded automated measures that can harness the data processing and analytical capabilities of the advanced C^4I system itself, so that future commanders can readily assess the training proficiency of their staffs.

As capabilities of advanced C^4I systems are enhanced, future experimentation should lead to further development of training methods (particularly for developing staff teams) that target cognitive skills needed on the digital battlefield. The recently adopted TRADOC Digital Learning Strategy envisions a 5-step process to train commanders and staffs (DA, 1998). The prototype staff training package designed and developed during this project incorporates several steps of that strategy and can serve as a development model for training future commanders and battle staff to gain and maintain battlefield dominance.

The literature reviewed during this project indicates that tactical decision-making skills can be improved with training that focuses on pre-action analysis, examination of uncertainties

and weaknesses in a plan, and post-action discussion and reinforcement of lessons learned. Team orientation can be enhanced by training focused on understanding roles and functions, maintaining situational awareness, and attending to information flow management. The prototype staff training and evaluation package discussed in this report includes all of these elements.

Lessons learned during this project that are applicable to other researchers involved in designing training for future staffs include: a need for additional analysis to see if higher cognitive skill training, such as decision-making, should be integrated into C^4I system training or conducted separately; developing a strategy to increase unit leadership acceptance of team training sessions and to incorporate an outside facilitator to implement them; and the provision of individual job aids during training for complex C^4I system procedures.

Future research needs to be directed toward designing and developing evaluation methods and measures for staffs operating advanced C^4I systems. Among the specific areas to be researched is the utility of system-embedded evaluation methods and the appropriate relationship between outcome measures and performance measures. Current staff evaluation methods and performance measures which have been used for the last 10 years do not reflect the greatly increased capabilities that emerging C^4I systems will provide to future staffs. Research should begin now so that when these advanced C^4I systems are operationally ready, performance evaluation methods and measures for the staffs operating them will be ready also.

Limitations in the methods developed and formative results reported are readily acknowledged. Prototype methods and Concept Experimentation Programs (CEPs) are, by their very nature, exploratory research efforts. In particular, the futuristic context of this research resulted in certain limitations. The prototype training and assessment methods developed for the CEP were designed for staffs operating with very advanced C4 systems in a fully digitized brigade environment. The prototype training and evaluation methods were designed to exploit the unique capabilities provided by a distributed interactive simulation test-bed. Also, as repeatedly noted, the prototype methods were not fully implemented or evaluated.

Despite these limitations, this research designed, developed and implemented prototype training and assessment methods for information age staffs. The training and assessment design was based on a review of the current, relevant literature. The specific methods were developed for implementation in a CEP examining the tools and structure for future battalion staffs. Lessons were derived concerning both specific development and implementation, and conceptual design of these methods. Future research should continue the effort to improve training and evaluation methods for future staffs.

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Appendix A

List of Acronyms

AA..................assembly area
AAR...............after action review
ADA...............Air Defense Artillery
ANCOC ....Advanced Non-Commissioned Officer's Course
AOAC............Armor Officer's Advanced Course
AOB...............Armor Officer Basic
APC ....Armored Personnel Carrier
ARI ................U.S. Army Research Institute for the Behavioral and Social Sciences
ARPA.............Advanced Research Projects Agency
Arty................Artillery
ARSI ....Advanced Research Projects Agency Reconfigurable Simulator Initiative

BCR ....Battle Command Reengineering
BDA...............Battle Damage Assessment
BF ....Battle Force
BLEFR...........Battle Lab Experiment Final Report
BLEP..............Battle Lab Experiment Plan
BLUFOR........blue forces
BNCOC..........Basic Non-Commissioned Officer's Course
BPV................battlefield planning visualization

C2...................command and control
C2V................command and control vehicle
C^4I.................command, control, communications, computer and intelligence
CAS ....Close Air Support
CAU ....crewman's access unit
CCIR..............commander's critical information requirements
CEP................Concept Experimentation Program
CIC.................Combat Information Center
COA...............course of action
CPU ....Central Processing Unit
CSS ....combat service support
CVCC ....Combat Vehicle Command and Control

DA..................Department of the Army
DC..................Deputy Commander
DCA...............Data Collection and Analysis System
DIS ....distributed interactive simulation
DTLOMS.......doctrine, training, leader development, organizations, materiel, and soldiers

EEFI...............Essential Elements of Friendly Information

FBC................Future Battlefield Conditions
FLOT ....forward line of troops
FM..................Field Manual
FOV ....field of view
FRAGO..........fragmentary order
FSE ....fire support element

GCM ....graphic control measures
GOFER ....Goals, Options, Facts, Effects, and Review
GUI ....Graphical User Interface

HMD ....helmet-mounted display
HumRRO ....Human Resources Research Organization

IAW ....In Accordance With
IB ....international border
IFV.................infantry fighting vehicle
INTSUM........intelligence summary

LD..................Line of Departure
LOA ....Limit of Advance

MCOO ....modified combined obstacle overlay
MDMP ....military decision-making process
METT-TC .....mission, enemy, terrain, friendly troops, time, and civilian considerations
MIBR ....motorized infantry brigade
MMBL...........Mounted Maneuver Battlespace Lab
ModSAF ....Modular Semi-Automated Forces
MOP...............Measure of Performance
MUAV ....Micro Unmanned Aerial Vehicle

NCO...............Non-Commissioned Officer
NDM..............Naturalistic Decision-Making
NLOS ....non-line of sight

O/C.................observer/controller
O/O ....on order
ODCI.............Observer's Data Collection Instrument
OIC ....officer-in-charge
OPFOR ....opposing force
OPORD..........operations order

PDA ....Personalized Decision Analysis
POI.................program of instruction
PVD ....plan view display

RA..................research assistant
RBC ....Reengineered Battle Command
RPD ....Recognition Primed Decision
R&S ....Reconnaissance and Surveillance
RSTA.............Reconnaissance Surveillance Target Acquisition

SC^4 ....surrogate command, control, communications, and computer
SITREP..........Situation Report
SITTEMPS ....Situational Template
SME...............subject matter expert
SOP................standing operating procedure
SOV ....Staff Operations Vehicle
SPOTREP......Spot Report
STIM..............Staff Training in Information Management
STO................Science and Technology Objective

TACSOP........tactical standing operating procedure
TACT.............Team Adaptation and Coordination Training
TARGETs......Target Accepted Responses to Generated Events or Tasks
TDG...............Tactical Decision Game
TDX...............tactical decision-making exercise
TF...................Task Force
TRADOC.......U.S. Army Training and Doctrine Command
TSP ....training support package
TTP ....tactics, techniques, and procedures
TTS ....Team Training Sessions

UAV...............unmanned aerial vehicle
UGV...............unmanned ground vehicle
USAARMC ...U.S. Army Armor Center
USMC...........U.S. Marine Corps

VTC ....video teleconference

WARNO........warning order

Appendix B

Sample Materials from Volume 1 of the
Training and Measurement Support Package

This appendix provides a sample set of the materials contained in *Volume 1: Overview and Front-End Analysis for Training and Measurement.* Volume 1 is part of the five volume set, *Training and Measurement Support Package, Mounted Maneuver Battlespace Lab, Battle Command Reengineering III* (Training and Measurement Support Package, 1999), which documents the work performed in the design of a prototype training program and evaluation package.

The purpose of this appendix is twofold. First, it provides the reader with samples of the front-end analysis products used in the development of the prototype training package. Secondly, the appendix provides a general overview of the topics and materials found in Volume 1. Training developers and others who are interested in the training of information age brigade and battalion level battle staffs may find this information of value to them.

The table below is the complete table of contents for Volume 1. The first column in the table provides the title for each product. The second column (where indicated) states whether this section contains a partial or a complete sample of the product and the last column identifies the page number.

Node Responsibility and Individual Job Responsibility Descriptions

Command 1 (Command Group): Provides the Commander with the capability to accurately assess the combat situation, continually track critical events, make timely decisions, and transmit his decisions to his subordinate commanders and higher headquarters.

Squadron Commander: Commands the Sqdn, initiates planning and decision-making, approves WARNOs/FRAGOs/OPORD, leads wargaming and rehearsals.

Effects Officer: Develops Sqdn fire plan, monitors and manages battlefield effects, initiates artillery and mortar calls for fire, tracks enemy Battle Damage Assessment (BDA), monitors Sqdn operational status.

Enemy Operations Officer: Analyzes Bde R&S plan, develops Sqdn R&S plan, directs scouts and sensors, tracks enemy BDA.

Command 2 (Deputy Commander): Coordinates and synchronizes combat support and combat service support activities. Assumes responsibilities of Command 1 if BCV1 is damaged or destroyed.

Deputy Commander: Chief of Staff. Monitors battle, manages terrain deconfliction, monitors Sqdn status.

Operations Officer: Coordinates with Bde for recon LD and LOA, assists with Sqdn R&S plan, manages satellite imagery, manages Close Air Support (CAS), monitors enemy movement and BDA.

Operations NCO: Creates operational graphics files, monitors fires effects, friendly operations, and Sqdn status.

Control 1 or Control 2 (in Current Ops Mode): Synchronizes current combat operations. Develops branches to current operations. Assumes responsibilities of Command 2 or Control 2 if BCV2 or SOV2 is damaged or destroyed.

Battle Captain: Manage OPORD development; receive, develop, coordinate & distribute WARNO to Sqdn; initiates whiteboard conference; distribute approved OPORD to Sqdn.

Friendly Operations NCO: Monitor current TF Class III/V and slant information, track CCIR.

Enemy Operations NCO: Track CCIR and Essential Elements of Friendly Information (EEFI), track frontline trace, supervise sensor NCO during sensor missions.

Sensor NCO: Operate sensors IAW Sqdn R&S plan, ensure Sqdn has latest enemy info.

Control 1 or Control 2 (in Future Ops Mode): Plans future operations while monitoring current situation for impact on future operations and maintaining current enemy situation. Assumes functions of Control 1 if SOV1 is damaged or destroyed.

Battle Captain: Review R&S plan overlays and fire plan overlays, review OPORD graphic control measure (GCM).

Friendly Operations Officer: Maintain friendly current situation, track CCIR, monitor fires effects, monitor Sqdn maintenance and supply status, track Sqdn repair and resupply, distribute Sqdn status, manage future CSS requirements.

Enemy Operations NCO: Track CCIR and EEFI, track frontline trace, supervise sensor NCO during sensor missions.

Sensor NCO: Operate sensors IAW Sqdn R&S plan, ensure Sqdn has latest enemy info.

Performance Analysis
(Mission Analysis and Wargaming)

Command 1		Command 2		Control 1 (Current)		Control 2 (Future)	
Actions	**With What**	**Actions**	**With What**	**Actions**	**With What**	**Actions**	**With What**
Continuous Actions							
Weather Data	E-Mail	Enemy battle damage assessment	PVD Spot Report (SPOTREP)	Current Class III, IV, V, IX status/resupply status	PVD	Sensor execution	UAV/Sensor display, UAV/Sensor PVD
Unit task organization	E-mail	Enemy contacts, locations, and movements	PVD	Main and forward aid station locations	PVD		
Monitor Bn status	PVD status tool	Maneuver companies: current location and activity	PVD, E-mail	Status of adjacent units	PVD		
		Location and status of mobility and countermobility assets	PVD, E-mail	Consolidation and reorganization status	PVD status		
		Obstacle or breach completion status	PVD, E-mail	Maintenance and casualty collection status	PVD status tool, E-mail		
		Target reference point emplacement	PVD, E-mail	Battalion personnel status			
				Sensor execution			
Event-Driven Actions							
1. Mission Analysis		1. Mission Analysis (implied tasks, R&S)		1. Mission Analysis (assess/confirm facts, status reports)		1. Mission Analysis (identify essential/implied tasks, make assumptions)	
1.1 Bde order w/graphics received by TF Cdr	E-mail & White Board						
1.2 Quick Assessment							
1.3 Bde order sent to other nodes	E-mail & White Board	1.3 Receives Bde order with graphics	E-mail & White Board	1.3 Receives Bde order with graphics	E-mail & White Board	1.3 Receives Bde order with graphics	E-mail & White Board

Performance Analysis, cont.
(Mission Analysis and Wargaming)

Command 1		Command 2		Control 1 (Current)		Control 2 (Future)	
Actions	With What	Actions	With What	Actions	With What	Actions	With What
1.4 TF Cdr reviews Bde plan w/Bde Cdr	White Board	1.4 DC monitors conference between TF Cdr and Bde Cdr	White Board				
1.5 TF Cdr's Initial Guidance	E-mail	1.5 Receives initial guidance	E-mail	1.5 Receives initial guidance	E-mail	1.5 Receives initial guidance	E-mail
1.6 TF Cdr's Enemy Ops Officer, using Bde's R&S plan, conducts R&S planning with other node Enemy Ops Officers and scouts	White Board and Terrain Tool on PVD	1.6 Enemy Ops Officer conducts R&S planning with TF Cdr's enemy ops officer	White Board conference and Terrain tool on PVD	1.6 Enemy Ops Officer conducts R&S planning with TF Cdr's enemy ops officer	White Board conference and Terrain tool on PVD	1.6 Enemy Ops Officer conducts R&S planning with TF Cdr's enemy ops officer	White Board conference and Terrain tool on PVD
		1.7 Friendly ops officer starts analysis of friendly status	PVD status tool	1.7 Friendly Ops officer begins prep of scheme of maneuver overlay	PVD	1.7 CSS NCO monitors unit status	PVD status tool
		1. 8 Tracks/responds to CCIR	PVD and E-mail	1.8 Tracks/responds to CCIR	PVD and E-mail	1.8 Tracks/responds to CCIR	PVD and E-mail
1.9 Cdr receives staff input	E-mail						
				1.10 Prepares draft WARNO-1 and sends for approval	PVD graphic controls and E-mail		
1.11 Cdr receives draft warning order and reviews	E-mail						
1.12 Cdr approves WARNO-1 and sends to Current Ops	E-mail						

SC4 Tool Descriptions

SC4 TOOLS	**DESCRIPTION**
File	Provides options for file and preferences
New Scenario	Clears PVD of all overlays and allows for construction of new scenario.
Load/Save/Delete User Preferences	Set up in *User Preferences* toolbar and save.
Save Overlay to File	Save an overlay to a file.
Load Overlay File	Load an overlay for use with the *Overlay Editor* toolbar button
Delete Overlay File	Permanently deletes overlays from the (CPU). Do not use unless directed.
Quit	Terminates MODSAF program. Do not use unless directed.
Map Scale	Used to change map scale from 1:500,000 down to 1:250. Force the map display to zoom in or out to fit a desired scale.
Map Features	Turn on and off various terrain features to provide the amount and type of info required.
Show As	Change how friendly and enemy units are displayed on the PVD.
Vehicle Pictures	Displays individual vehicle pictures.
Vehicle Icons	Displays vehicles as individual icons.
Agg Platoons	Displays platoon aggregate units.
Agg Companies	Displays company aggregate units.
Special	
Toggle Status Display	Used to select icons (blue or red) and receive either a SPOTREP (enemy) or SITREP (friendly).
Freeze Display	Allows the current situational awareness display to be frozen and saved to use as a whiteboard tool.
Show Editor	Forces space at the bottom of the PVD to remain open so that when a toolbutton is enabled the map is not redrawn.
TOOLBAR BUTTONS	Buttons down left side of screen.
Text Editor	Place text in a selected overlay.
Line Editor	Place lines in a selected overlay.
Area Editor	Place areas in a selected overlay.
Point Editor	Place points and unit symbols in a selected overlay.
PVD Controls	Limited configuration display of the PVD.
User Preferences	Establish how information is displayed on the PVD. Do not use unless directed.
Stealth Control	Place the stealth viewer at a specific location on the map.
Delete Tool	Delete objects from overlays.
Overlay Editor	Create new overlays, and turn on and off overlays on the PVD.
Call For Fire Tool	Send a call for fire directly to the FDC without using voice communication.
Terrain Tool	Analyze terrain for intervisibility and to generate a terrain profile.
Field of View Tool	Analyze terrain for FOV for both sensors and weapon systems and generate an overlay of that FOV for use in planning.
Snail Display	Analyze unit movement over selected periods of time and generate an overlay of that unit movement for use in planning.

SC4 Functions

Four basic SC4 functions were identified, and a fifth category was defined to include functions that are not included in the SC4 system, but that add to the commander's situational awareness.

Each function is defined below. The functions are:

- Common Relevant Picture Management,
- Information Management,
- Conference Management,
- Orders Production, and
- Other Support Functions (e.g., UAV, Battle Planning and Visualization Display [BPV]).

These functions served as the foundation for Level 3 training.

Common Relevant Picture Management

The tools and procedures that allow the commander and his staff to develop a clear understanding of his current situation in relation to the enemy and environment. Two areas within this function are SITTEMPs and CCIRs. Activities includes:

- getting different kinds of information from the PVD display,
- viewing one or more overlays on the PVD,
- using tools for terrain analysis and fields of view,
- viewing history of troop movements (past 60 minutes),
- projecting enemy movements,
- setting up event boxes for automatically monitoring critical events, and
- using the PVD and other tools to answer commander's requirements for information.

The activities emphasized are slightly different for each of the following participant groupings:

- Effects Officer – Battle damage, positioning.
- Operations/Friendly Ops – Status of friendly forces, staff estimates.
- Enemy Ops – Monitoring, interpreting, predicting enemy activity.

Continued on next page

Information Management

The tools and procedures that allow the commander and staff to gain a fuller understanding of the current situation by accessing, processing, disseminating, and storing information that cannot be readily projected onto a common relevant picture display (i.e., the PVD). This function covers status reports, spot reports, and electronic messaging. Activities include:

- reviewing PVD tools and screen arrangement,
- getting reports of friendly and enemy situation, status, and activity, and
- managing e-mail capabilities and features.

The activities emphasized are slightly different for each of the following participant groupings:

- Vehicle Commanders – Access to all information (including stealth view) while not overloading with all details all the time.
- Friendly Operations Staff – Friendly forces activities, situation reports, and status.
- Enemy Operations Staff – Enemy activities and projections.
- Sensor Operators – Comparing information from multiple sources to aid in interpretation.

Conference Management

The tools and procedures that allow the commander to communicate his decisions, guidance, and intent in situations where the commander, his staff, and subordinate commanders are geographically dispersed. These tools also facilitate the commander's ability to supervise and adjust his subordinate forces' execution to ensure compliance with his intent. Activities includes:

- using the whiteboard for inter-node planning, wargaming, and rehearsals and
- using video teleconferencing (VTC), with and without the whiteboard.

Continued on next page

Orders Production

The tools and procedures that allow the commander and his staff to communicate the commander's decisions, guidance, and intent to superior and subordinate commanders and staff in a commonly understood format in situations when there is sufficient time for the commander and staff to formally record the decision-making process. It also includes transmitting the results to subordinate commanders in time for them to understand the commander's intent without impacting on the unit's preparatory activities.

Overlay production is done on the PVD. The rest of the order will generally be done via the whiteboard.

Other Support Functions

The tools and procedures that are not included in the SC4 system, but that add to the commander's situational awareness. Examples of these tools include:

- UAV Sensor Control,
- BPV,
- Satellite, and
- Netscape Navigator.

SC4 Tools by Functions Crosswalk

Tools	Common Relevant Picture Mgt	Conference Mgt	Information Mgt	Orders Production	Other
PVD					
File					
New Scenario					
Load/Save/Delete User Preferences					
Save Overlay to File				x	x
Load Overlay File				x	x
Delete Overlay File				x	x
Quit					
Map Scale	x	x	x	x	x
Map Features	x	x	x	x	x
Show As					
Vehicle Pictures					
Vehicle Icons					
Agg Platoons					
Agg Companies					
Special					
Toggle Status Display			x		
Freeze Display					
Show Editor					
TOOLBAR BUTTONS					
Text Editor	x			x	
Line Editor				x	x
Area Editor				x	x
Point Editor				x	x
PVD Controls	x				
* User Preferences					
Stealth Control			x		
Delete Tool				x	x
Overlay Editor	x			x	x
FSE (Call For Fire) Tool	x				
Terrain Tool	x		x	x	x
Field of View Tool	x		x	x	x
Snail Display	x		x		
Forward Line of Troops (FLOT) Display	x		x	x	x
PIR/CCIR Tool	x				x
Mouse Button Control					
Information	x		x	x	x
Pan				x	
Environmental Information			x	x	x

Functions by Responsibilities Crosswalk

	Command 1									
	Commander				Effects Officer			Enemy Operations Officer		
Functions	Cmd TF	Dir DMP	Approve orders	Leads wargame & rehearsals	Develop effects plan	Manages battlefield effects	Monitor TF ops status	Develop TF R&S plan	Directs scouts & sensors	Analyzes enemy COA
Common Relevant Picture Management	X	X	X	X	X	X	X	X	X	X
CCIR						X	X	X	X	X
Conference Management										
Radio	X	X		X		X			X	X
Whiteboard		X	X	X		X		X		X
VTC -- set up, turn on, turn off	X									
Information Management (Access Reports, Data, etc)										
Status Reports (Friendly)	X	X				X	X	X	X	X
Spot Reports (Enemy)	X					X	X	X	X	X
Electronic Messaging -- write, format, send, read, forward, delete, and save	X		X						X	X
Files						X				
Orders Production										
OPORD			X		X			X		
FRAGO			X		X			X		
WARNO			X							
Overlays			X		X			X		
SITTEMP						X	X		X	X
Other										
UAV Sensor Control										
BPV										
Satelitte										

Tool by Training Level Summary

Tools	Level 2	Level 3 Block 1	Level 3 Block 2	Level 3 Block 3	Level 3 Block 4	Level 3 Block 5	Level 4
PVD							
File	X			X	X		
New Scenario					X		
Load/Save/Delete User Preferences			X	X			
Save Overlay to File				X	X		
Load Overlay File	X			X	X		
Delete Overlay File				X	X		
Quit	X						
Map Scale	X	X	X	X	X		
Map Features	X	X	X	X	X		
Show As	X						
Vehicle Pictures	X						
Vehicle Icons	X						
Agg Platoons	X						
Agg Companies	X						
Special		X	X				
Toggle Status Display			X				
Freeze Display		X					
Show Editor		X					
TOOLBAR BUTTONS		X	X	X	X		
Text Editor				X	X		
Line Editor				X	X		
Area Editor				X	X		
Point Editor				X	X		
PVD Controls		X					
* User Preferences							
Stealth Control			X				
Delete Tool				X	X		
Overlay Editor		X		X	X		
FSE (Call For Fire) Tool				X			
Terrain Tool		X	X	X	X		
Field of View Tool		X	X	X	X		
Snail Display		X	X	X			
Forward Line of Troops (FLOT) Display		X	X	X	X		
PIR/CCIR Tool		X		X			
File Tool							
Snap Tool							

Appendix C

Sample Materials from Volume 2 of the
Training and Measurement Support Package

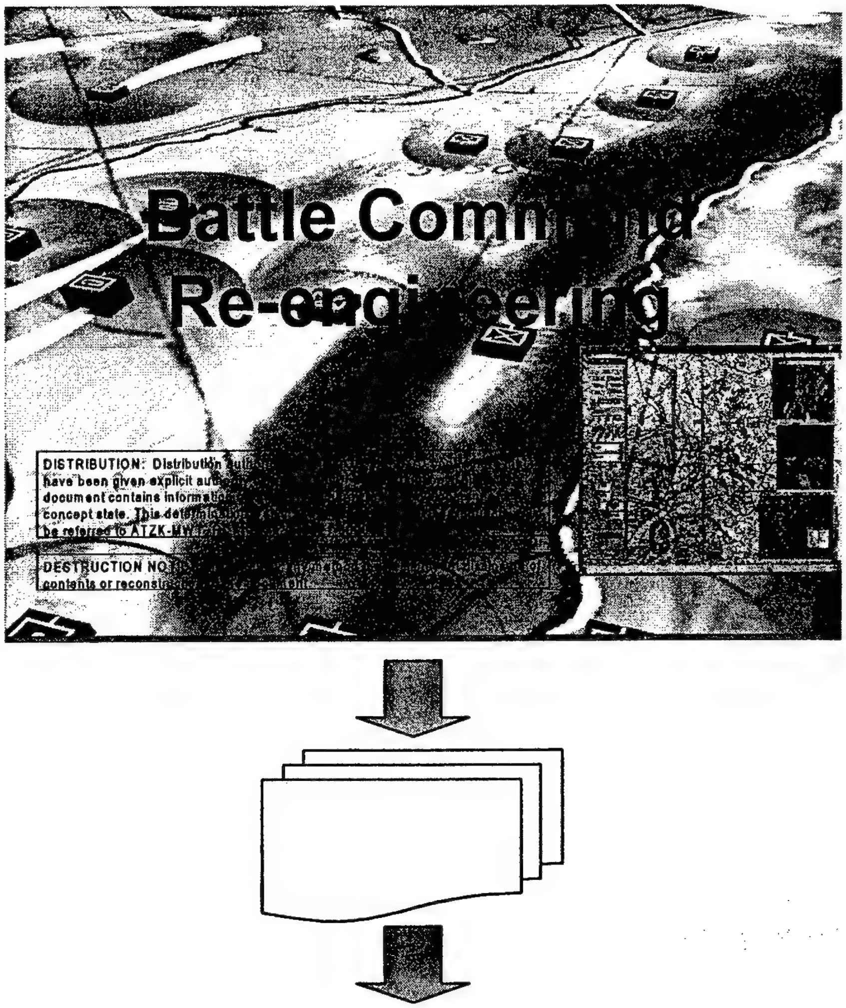
This appendix provides a sample set of the materials contained in *Volume 2: Initial Orientation and Train-Up*. Volume 2 is part of the five volume set, *Training and Measurement Support Package, Mounted Maneuver Battlespace Lab, Battle Command Reengineering III* (Training and Measurement Support Package, 1999), which documents the work performed in the design of a prototype training program and evaluation package.

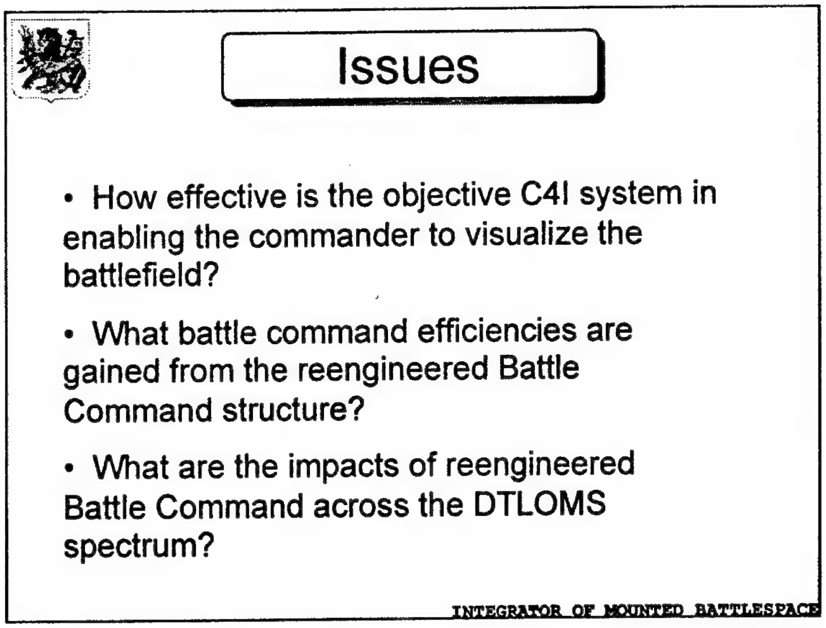
The purpose of this appendix is twofold. First, it provides the reader with brief samples of the orientation and train-up materials that were mentioned in the report for use in conducting the prototype training. Secondly, the appendix provides a general overview of the topics and materials found in the Volume 2. Training developers and others who are interested in the training of information age brigade and battalion level battle staffs may find this information of value to them.

The table below is a general table of contents for Volume 2. The first column in the table provides the title for each product. The second column (where indicated) states whether this appendix contains a partial or a complete sample of the product and the last column identifies the page number.

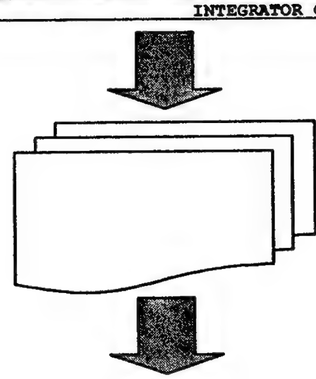
Volume Title	**Appendix Sample**	**Appendix Page**
Overview		
Training Schedule	Not Provided	--
Level 1: Initial Orientation		
Training Plan Outline	Not Provided	--
Initial Orientation Slides	Partial	C – 2
Level 2: Fundamentals Training		
Training Plan Outline	Partial	C – 4
Signal Operating Instructions Extract	Not Provided	--
Structured Practice Exercise	Partial	C – 5
Level 3: Functions Training		
Training Plan Outline	Not Provided	--
Signal Operating Instructions Extract	Not Provided	--
Structured Practice Exercise	Not Provided	--
Level 4: Tasks Training and Practice		
Training Plan Outline	Not Provided	--
Attachments to Level 4	Not Provided	--

ADVANCE ORGANIZER FROM INITIAL ORIENTATION





Advance Organizer from Initial Orientation, cont.



Initial Orientation - Level 1

An Advance Organizer Approach

	Current	BCR III
– Staff Structure	Commander, primary and special staff	Commander with Command group and three C2 nodes
– METT-TC	Missions, Enemy Doctrine, Sensors, etc.	Missions, Enemy Doctrine and Capability, Sensors, etc.
– CPs and Equipment	Main, Rear, TAC; radios, ASAS, MCS...	C2 Nodes and functions; SC4 systems
– Planning Processes	Military Decision-Making Process, plans cell	Collaborative planning, current and future ops nodes

Preview of Experiment Process, Training (TDX, Tasks, Functions, Fundamentals) for 2 hours on Day 1

INTEGRATOR OF MOUNTED BATTLESPACE

Level 2 Training Plan Outline, Continued

Level 2 instruction, computer display management

3. Computer display management (30 min., SPE 10 minutes)

a. *Briefly review computer monitors and uses*

b. Identify the Workspace Menu
   - **Show how** to access
   - Briefly describe run ModSAF and C2 (bring up the three basic GUI windows)

c. Name and describe the three basic display windows
   - Describe graphic user interface (GUI) windows
     - Plan View Display (PVD)
     - Netscape Mail (E-mail)
     - Simplicity ™ Whiteboard (Whiteboard)
   - Note to avoid closing any GUI window

d. GUI window manipulation
   - **Show how** to bring forward, maximize, restore, move, resize, minimize, restore minimized window
   - **Show how** to set up the suggested optimal window arrangement

e. Point out general use for the three GUI windows
   - PVD provides the common situational awareness picture (e.g., terrain, overlays, call for fire)
   - email provides written communication between nodes
   - whiteboard provides capability to conference on-line between nodes with text and graphic files

Conduct Structured Practice Exercise Set B for computer display management

Continued on next page

Structured Practice Exercise

Set B: Computer Display Management (1 of 3)
1. The Workspace Menu contains options to re-start GUI windows. To obtain the Workspace Menu, right click anywhere on the monitor screen where there is not an open window 2. Bring up the GUI windows; PVD, Whiteboard, E-mail (may need to close them first) 3. To remove the workspace window from the monitor screen, left click once anywhere on the monitor screen 4. To bring the Netscape Mail window forward, which is used to send or receive e-mail, click on the header bar at the top of the window 5. To see the terrain map, click on the header bar of the PVD (ModSAF) window 6. Maximize the PVD (ModSAF) window size by clicking on the maximize tool button located on the far right at the top of the window 7. Restore the PVD window screen size by clicking on the same button 8. Click and hold on the top header bar of the PVD window and move the window to the bottom of the monitor screen 9. Bring forward the Whiteboard window by clicking on the header bar of the window 10. Resize the whiteboard window by grabbing a corner of the window with the mouse and expanding the window 11. Minimize the whiteboard window by clicking on the minimize button (next to the maximize button) at the top of the window, the ICON labeled Whiteboard will appear on the left side on the monitor screen 12. Should the whiteboard ICON be covered by another window, move that window out of the way by clicking and holding on the top header bar 13. Click once on the Whiteboard ICON to obtain menu options 14. Click on the Restore option to bring up the whiteboard window 15. Minimize the whiteboard window, click the minimize button at the top of the window 16. Double click on the Whiteboard ICON to restore the window 17. Assist the training audience in returning the monitor screen back to the original recommended window arrangement. (All three header bars can be seen at the same time, with the Netscape window to the top left, whiteboard to the top right, and PVD just below those in the center of the screen)

Appendix D

Sample Materials from Volume 3 of the
Training and Measurement Support Package

This appendix provides a sample set of the materials contained *Volume 3: Tactical Decision-Making Exercises and Team Training Sessions.* Volume 3 is part of the five volume set, *Training and Measurement Support Package, Mounted Maneuver Battlespace Lab, Battle Command Reengineering III* (Training and Measurement Support Package, 1999), which documents the work performed in the design of a prototype training program and evaluation package.

The purpose of this appendix is twofold. First, it provides the reader with brief samples of selected training materials that were mentioned in the report designed and developed to conduct the TDXs. Secondly, the appendix provides a general overview of the topics and materials found in the volume. Training developers and others who are interested in the training of information age brigade and battalion level battle staffs may find this information of value to them.

The table below is a general table of contents for Volume 3. The TDX sample materials are taken from TDX 1, Mission Analysis and Wargaming. Although the TDX Workstation Guidelines include instructions for various OPFOR or BLUFOR workstations, only one guideline (OPFOR workstation) is provided as an example.

The first column in the table provides the title for each product. The second column (where indicated) states whether this appendix contains a partial or a complete sample of the product and the last column identifies the page number.

Volume Title	Appendix Sample	Appendix Page
Overview	Not Provided	--
Training Director Guidelines	Partial	D – 3
TDX Structure*	Complete	D – 4
TDX 1: Mission Analysis and Wargaming		
TDX Overview	Complete	D – 5
TDX Event Description	Partial	D – 6
TDX Event Guide	Partial	D – 7
TDX Workstation Guidelines	Partial	D – 8
Tactical Materials	Complete	D – 9
TDX Plan Sheets	Partial	D – 10
TDX 2: Rehearsal		
(similar materials as TDX 1)	Not Provided	--
TDX 3: Execution of a Squadron Branch		
(similar materials as TDX 1)	Not Provided	--

(table continues)

Table 5 (Continued)

Volume Title	Appendix Sample	Appendix Page
TDX 4: Execution of a Squadron Sequel		
(similar materials as TDX 1)	Not Provided	--
Attachments		
Signal Operating Instructions Extract	Not Provided	--
Team Training Sessions Slides	Partial	D – 11
Tactical Materials for Level 5	Not Provided	--
Acronyms	Not Provided	--

Note. The item marked with an asterisk (*) is not a separate document in Volume 3. It is part of the Volume 3 Training Director Guidelines and is provided to summarize the general TDX phases and associated activities.

Training Director Guidelines

Training Director Guidelines for Level 5

Introduction

This guide provides instructions for the Training Director for execution of the tactical decision-making exercises (TDX).

Purpose

The material in this section has three purposes:

- to provide an overview to the TDXs,
- to describe the relationship and roles of the Training Director, and
- to outline procedures before, during, and after the TDXs.

Exercise characteristics

The TDXs have the following characteristics:

- The exercises use the ModSAF constructive simulation.
- It is not a simulation supported command post exercise (CPX). The orders and decisions generated by the squadron are carried out by subordinate units, who are required to conduct their own troop leading procedures as required to develop their own plans.
- The exercises are designed to mirror experiment-like conditions, and focus on collective battle staff skills that are most likely to be used during the experiment.
- The structured training support materials provide the instructions required for all training participants and support personnel as well as the tactical materials required to support all four exercises.

Training Director's role

As the Training Director, you are the primary trainer of the squadron commander and his staff on the operation of the SC4 system which supports his decision-making process. Your role is to coordinate and run the exercises. You have authority to halt or delay the exercise, activities or events specified in the TDX event guide, although the squadron commander may request to adjust the TDX event time line once the exercise has started based on his estimate of his unit's proficiency on applying SC4 tools to the decision-making process. The squadron commander should be a key player in assisting you in determining whether his unit is proficient enough with the SC4 to undertake the BCR III experiments.

Continued on next page

Training Director Guidelines for Level 5, Continued

Responsibilities

Your responsibilities in preparing for and conducting the TDXs include:

- Making training management decisions to modify execution of the exercise in conjunction with the squadron commander,
- Acting as the BF higher commander to resolve any issues that the White Cell does not feel qualified to answer,
- Monitoring the progress of the exercise from the perspectives of the White Cell, OPFOR, and training audience.
- Issuing instructions to the OPFOR commander to adjust his time line or course of action to facilitate training for the participants.

What to do next as the Training Director

To begin your preparation as the Training Director:

- Read the following sections of this volume:

  TDX 1: Mission Analysis and Wargaming

  TDX 2: Rehearsal

  TDX 3: Execution of a Squadron Branch

  TDX 4: Execution of a Squadron Sequel

  Team Training Session Materials for Level 5
- Meet with the key exercise personnel to review and coordinate the requirements outlined to conduct the exercises
- Confirm the published TDX training timeline

TDX Structure

TDX structure

There are three phases to a TDX: Pre-execution, Execution, and Post-execution. Descriptions of the phases and the sequence of activities in each TDX are provided in the following table.

Phase	Activity	Description	Materials
Pre-Execution	TDX Description	Training Director provides a brief description of the TDX and the exercise training objective(s). If necessary, the starting locations for squadron units is also provided.	Training Director Guidelines TDX Overview
	Pre-Action Analysis (TTS Session)	Training Director facilitates Pre-Action Analysis initially. Goal is to have Squadron Commander facilitate this session.	TTS Slides
Execution	Begin TDX	Training Director uses the TDX event guide to control and cue unit training.	TDX Event Guide TDX Guidelines
	Commander's Timeout (TTS Session)	Training Director facilitates Commander's Timeout initially. Goal is to have Squadron Commander facilitate this session.	TTS Slides
Post-Execution	Team Decision-Making Debrief Coordination	Training Director assembles O/Cs and training observers to identify problems and issues for Team Decision-Making Debrief.	Training Director Guidelines
	Team Decision-Making Debrief (TTS Session)	Training Director facilitates the Team Decision-Making Debrief initially. Goal is to have Squadron Commander facilitate this session.	TTS Slides
	Unit AAR	Squadron Commander facilitates AAR per unit SOP if tactical AAR is desired.	Not Provided

TDX Overview

TDX 1: Mission Analysis and Wargaming

Introduction

This TDX provides the Sqdn Commander (Cdr) and staff decision-making practice using SC4 tools under experiment-like conditions. The exercise limits current operation requirements so that the battle staff focus is on developing techniques and procedures for their decision-making process.

Purpose

The material in this appendix has two purposes:

- to describe the actions of the Training Director, White Cell, and OPFOR workstation operators and
- to outline procedures before, during, and after the TDX.

Contents

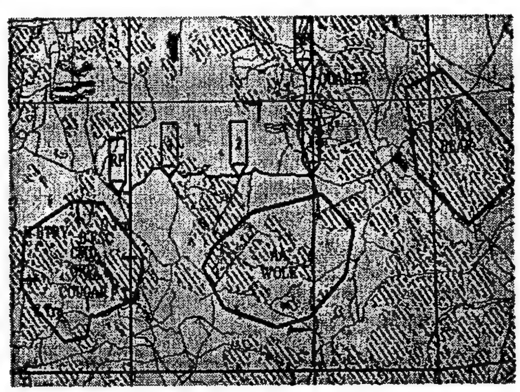
The following materials are found in the TDX 1 section:

TDX 1: Mission Analysis and Wargaming, Continued

TDX overview

The Strike Force has been ordered to move from the Grafenwohr airhead, occupy AA COUGAR, and to be prepared to commence combat operations within 8 hours. F3 troops are reporting they have exchanged fire with dismounted El Doradian reconnaissance forces along the international border. Joint Task Force Headquarters reports El Doradian Forces have ceased electronic transmissions, their air force has stood down, and ground force units are moving from cantonment areas to dispersal sites. Combat units in the border area have been detected moving slowly toward the border. El Doradian government representatives have requested an urgent meeting with international mediators to protest provocative U.S. military activities.

TDX event diagram



Continued on next page

TDX 1: Mission Analysis and Wargaming, Continued

Event descriptions

This table provides the event and event descriptions for this exercise.

EVENT	Description
1. TDX Overview	Unit assembles at training site. Training Director conducts in-brief, Pre-Action Analysis team training session, and establishes startex time.
2. Battle Force issues order and INTSUM	Squadron uses a movement order provided to them to move from an airhead to AA COUGAR. During movement the squadron receives an INTSUM and an order from the BF for a defensive operation.
3. 2nd Squadron occupies assembly area	Squadron occupies AA COUGAR. During occupation squadron receives BF order. Squadron Commander conducts confirmation brief to BF commander.
4. Commander's Timeout	At a time determined by the Squadron Commander, the exercise is paused for a Commander's Timeout exercise. The Squadron Commander informs the staff of his answers to a series of specific questions regarding situational awareness at specific times or events during the TDX.
5. 2nd Squadron Scouts establish screen line	Squadron establishes a screen line in sector along PL TEXAS as directed in the BF order.
6. 2nd Squadron develops and issues Defense order	Squadron completes its decision-making process and issues its order to its subordinate units. During the process the squadron commander back briefs his plan to the BF commander.
7. Team Decision-Making Debrief	Training Director conducts the Team Decision-Making Debrief and releases unit to the Squadron Commander for tactical AAR.

TDX 1 Event Guide

Purpose

The *TDX 1 Event Guide* provides exercise and control instructions for the Training Director, White Cell, and OPFOR.

EVENT 2: Battle Force issues WARNO and INTSUM

Training Director Note/Event/Message Traffic	Unit Action	White Cell	OPFOR Action	Done (✓)
	Sqdn Cdr reports unit at REDCON1.			
Note: Training Director acknowledges report and directs unit to begin movement to AA COUGAR.				
"Cougar 6, this is Dragoon 6. Roger. Initiate movement at this time, over."	Unit begins movement.			
Note: When lead element of unit reaches CP1, direct the White Cell to release INTSUM 99-04-14-1.		White Cell releases INTSUM (E-Mail message #1).		
Note: When lead element of unit reaches CP3, direct the White Cell to release BCR3_TDX1_WARNO.		White Cell releases BCR3_TDX1_WARNO (Whiteboard Message #1).		

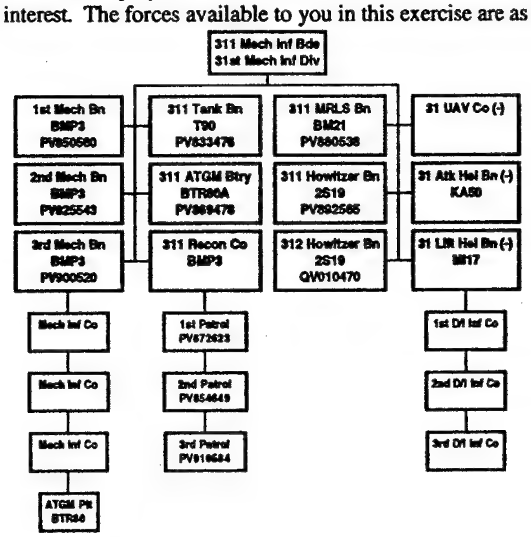
OPFOR Workstation Execution Guidelines

Overview

As the OPFOR workstation operator, you will need the following information to support the execution of the TDX 1 exercise.

Focus

The purpose of your actions in controlling the OPFOR is to provide the Squadron with an opportunity to collect intelligence information about the compositions and deployment of the forces that are opposing them in their area of interest. The forces available to you in this exercise are as follows:



Enemy intent

The intent of the OPFOR is move its forces from their march column formations used to approach the border area into more dispersed formations along side of roads which decrease their vulnerability to air attack and yet permit them to rapidly resume their approach to the border.

OPFOR Workstation Execution Guidelines, Continued

Exercise guidance

At the direction of the OPFOR Controller, you will begin to move your forces out of their column formations into more dispersed formations in close proximity to the road network. Attempt to maximize use of the available cover in the area. Once this repositioning has been accomplished, no other OPFOR activity is anticipated. If BLUFOR UAVs attempt to cross the international border, engage them with the appropriate weapon systems. Be prepared to assist in developing additional intelligence information about the OPFOR which the White Cell may have to provide in response to information requests from the experimental unit.

Rules of engagement

Ensure that OPFOR reconnaissance patrols do not cross international border. While dispersing units, minimize movement toward the border that might be interpreted as the initiation of hostilities by the experimental unit.

Tactical Materials

Purpose

The Battle Force (BF) tactical materials provide the cues that initiate squadron operations and the battle staff's decision-making process. During the exercise they are transmitted electronically from the White Cell using the whiteboard, overlay files, or a combination of both. Paper copies, including overlay sketches, are provided in this section and the attachment for preparation and reference during the exercise.

Materials

The Brigade Order with RSTA, Effects, and CSS are located in the attachment 5-6-1. Found on the following pages, the other tactical materials for this TDX are:

TACTICAL MATERIAL	*Time / Event of Issue*	Mode of Issue
Sqdn Movement Order	At start of the exercise	Whiteboard
Movement Overlay	With movement order	Overlay file
INTSUM 99-04-14-1	When sqdn lead element reaches CP 1	Whiteboard
WARNO 99-01 (Order # 1)	When sqdn lead element reaches CP 3	Whiteboard
WARNO Overlay	With WARNO 99-01	Overlay file

TDX 1 Plan Sheets

Purpose T contains the ModSAF plan sheets that document locations and conditions of BLUFOR and OPFOR entities at the start of TDX 1. These plan sheets should not be needed unless the existing ModSAF files are damaged.

Experimental Unit Data					
Unit Type	**Unit ID**	**Location**	**Azimuth**	**Formation**	**Remarks**
2nd Sqn, 2nd Strike Force					
	HQ66	QA102108	280	Column	Command 1
	HQ65				Command 2
	HQ63				Control 1
	HQ62				Control 2
UAV	HQ71				
UAV	HQ72				
MIB	HQ81				
MIB	HQ82				
MIB	HQ83				
MIB	HQ84				
E Troop					
FV	A66	QA107106	280	Column	
FV	A55				
D/I Inf	Fire Tm A, HQ Sqd				Rides A66 until dismounted
D/I Inf	Fire Tm B, HQ Sqd				Rides A55 until dismounted
1st Plt					
FV	A11				
MAV	A12				A16 Robotic Follower w/NLOS missiles
FV	A13				

Pre-Action Analysis

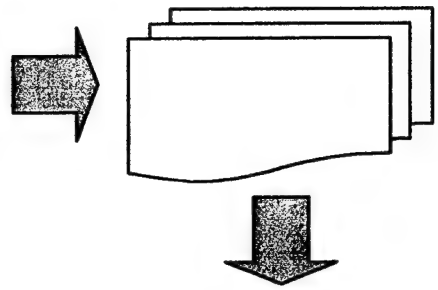
Cdr's vision of TDX process and end-state

Key TDX events

Team's roles and functions per events

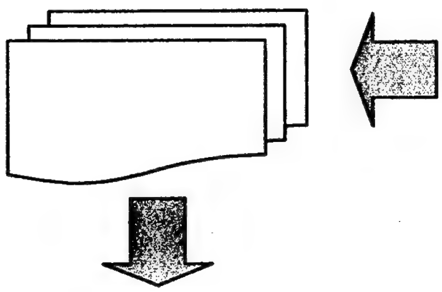
- What will you be doing?
- Who will you need to work with?
- Products?

Challenges (information management, situational awareness, & workload)



Commander's Timeout

- Cdr's vision of current situation & goal:
- Cdr's biggest concern now:
- Cdr's information needs:
- Cdr's expectations (30-60 minutes into the future):



Team Decision-Making Debrief

- What were the tough decisions?
- Why were they difficult?
  - Situational awareness: What was the situation at the time?
  - Information management: What information did you have? What information did you need?
  - Roles and functions: Was it always clear what you were supposed to be doing?

Appendix E

Sample Materials from Volume 4 of the
Training and Measurement Support Package

This appendix provides a sample set of the materials contained *Volume 4: Measures.* Volume 4 is part of the five volume set, *Training and Measurement Support Package, Mounted Maneuver Battlespace Lab, Battle Command Reengineering III* (Training and Measurement Support Package, 1999), which documents the work performed in the design of a prototype training program and evaluation package.

The purpose of this appendix is twofold. First, it provides the reader with brief samples of the measures used to evaluate the training and staff performance during BCR III that were mentioned in the report. Secondly, the appendix provides a general overview of the topics and materials found in Volume 4.

The table below provides a list of the materials found in Volume 4 that are discussed in this report. Although surveys and interviews were designed to evaluate training as well as to provide feedback on the BCR III issues, only one training survey and interview sheet are provided as samples. The first column in the table provides the title for each product. The second column (where indicated) states whether this appendix contains a partial or a complete sample of the product and the last column identifies the page number.

Volume Title	**Appendix Sample**	**Appendix Page**
Automated Measures	Not Provided	--
Surveys	Partial	E – 2
Observer's Data Collection Instrument	Partial	E – 5
Interviews	Partial	E – 6

Training Survey Day 5 – TDX 4

Instructions:
Earlier this week you learned and practiced basic and advanced skills using the SC4 system. Today you participated in TDX4, Brigade Sequel. Please circle the number (1-5) that best represents your response, or write in your response, as appropriate, to the questions below.

1. My prior Tools, Functions, and Tasks training prepared me for this TDX.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

   a. What was missing from the training?

   ____

   b. What aspect of the training you received needs improvement?

   ____

2. The prior TDXs prepared me for this TDX.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

Describe how the prior TDXs did or did not prepare you for this TDX.

____

____

3. This TDX gave me a good chance to practice using the SC4 system.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

Describe how this TDX did or did not provide enough practice.

____

____

4. The OPORD and associated tactical materials gave me enough information for planning.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

Describe why the tactical materials did or did not give you enough information.

____

____

TRAINING SURVEY DAY 5 – TDX 4, CONT.

Instructions:
The following statements refer to three techniques introduced during training. The techniques are defined below. Please circle the number (1-5) that best represents your response to the items below.

Pre-Action Analysis: focuses on shared understandings of roles and functions, information management, workload, and situational awareness. Also helps anticipate potential problem areas and generate how these problems will be solved, should they arise.

Commander's Timeout: recalibrates the team to the Commander's situational awareness by allowing the Commander to stop and think about his situational awareness and to communicate that to the staff.

Team Decision-Making Debrief: discusses the utility of the Commander's Timeout and information management and roles and functions issues. Also identifies action items for sustainment and improvement.

	Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree
Pre-Action Analysis:					
5. This technique was useful in helping us work together as a team.	1	2	3	4	5
6. This technique would be helpful in future training.	1	2	3	4	5
Commander's Timeout:					
7. This technique was useful in helping us work together as a team.	1	2	3	4	5
8. This technique would be helpful in future training.	1	2	3	4	5
Team Decision-Making Debrief:					
9. This technique was useful in helping us work together as a team.	1	2	3	4	5
10. This technique would be helpful in future training.	1	2	3	4	5

TRAINING SURVEY DAY 5 – TDX 4, CONT.

11. What could we add, drop, or change to improve this week's training?

____

____

12. What could we add, drop, or change to improve the Pre-Action Analysis?

____

____

13. What could we add, drop, or change to improve the Commander's Timeout?

____

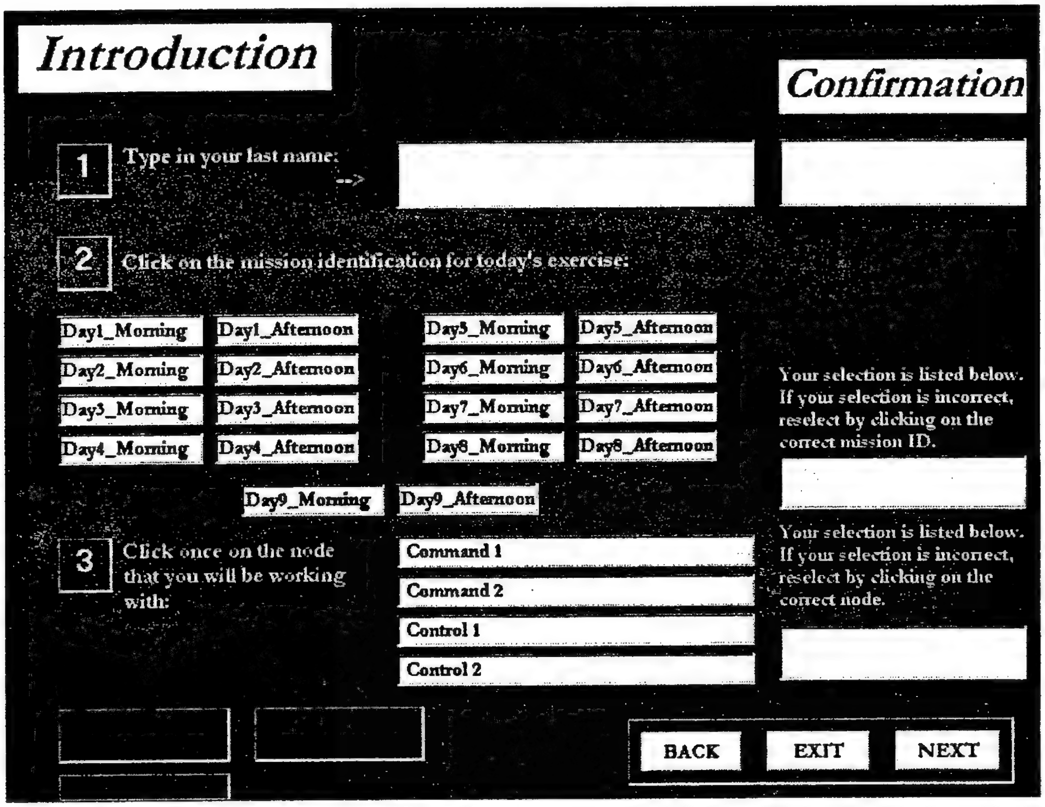
____

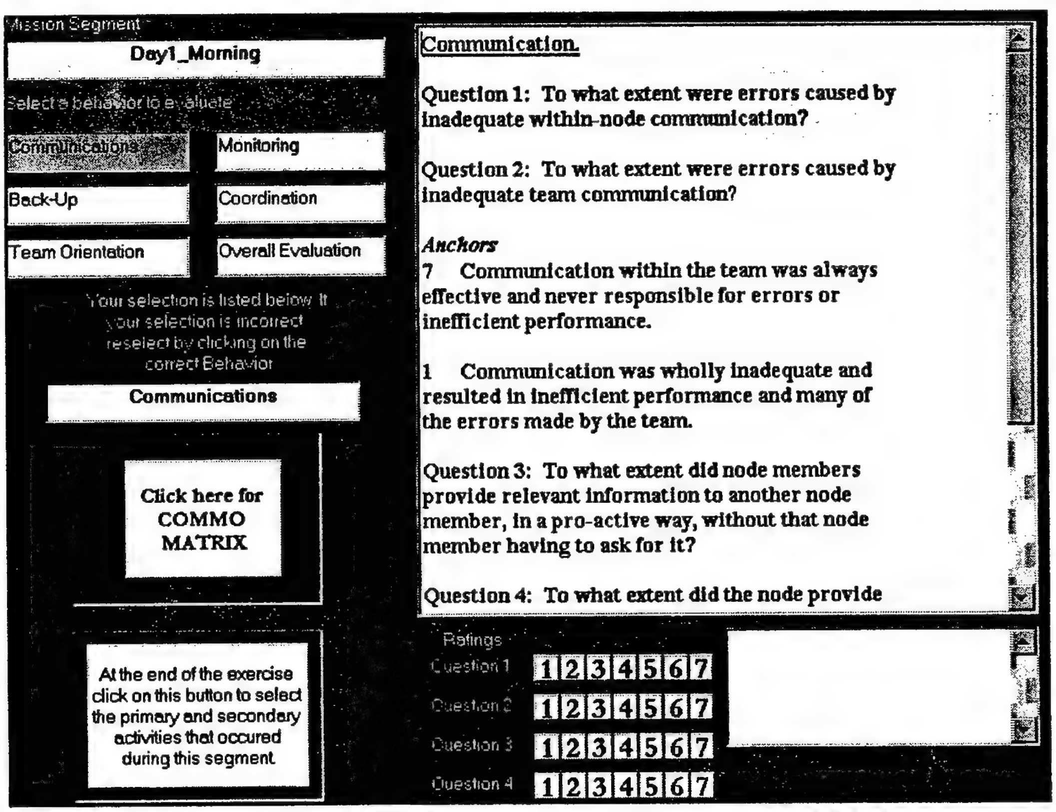
14. What could we add, drop, or change to improve the Team Decision-Making Debrief?

____

____

Observer's Data Collection Instrument





SQUADRON COMMANDER INTERVIEW SHEET – END OF EXPERIMENT

INTERVIEWER: ______________________________ DATE: ______________

The first question asks you to think about your key information. Then there are several questions focused on the SC4 system capabilities. The third set of questions addresses the staff organization and multifunctional staff Finally, there are some questions about the training.

SC4 SYSTEM CAPABILITIES

1. Generally, what were your key information requirements for:

   a. Planning

   b. Preparation/Rehearsal

   c. Execution

   d. Consolidation and Reorganization

2. Given the SC4 system, was the required information *accurate*?

3... (etc)

TRAINING

18. Did the training and practice (Levels 2-5) during Week 1get you and your staff proficient enough to use the SC4 system during the experiment?

19. Did the training and practice get you and your staff comfortable and proficient in working within the new staff organization?

20. Did the training and practice help your and your staff to understand the BLUFOR and OPFOR weapon system capabilities?

21. Did you continue to use the team training session procedures (pre-action analysis, commander's timeout, team decision-making debrief) after the training week? Why or why not?

Appendix F

Sample Materials from Volume 5 of the
Training and Measurement Support Package

This appendix provides a sample set of the materials contained *Volume 5: Data Collection*. Volume 5 is part of the five volume set, *Training and Measurement Support Package, Mounted Maneuver Battlespace Lab, Battle Command Reengineering III* (Training and Measurement Support Package, 1999), which documents the work performed in the design of a prototype training program and evaluation package.

The purpose of this appendix is twofold. First, it provides the reader with brief samples of the measures used to evaluate the training and staff performance during BCR III that were mentioned in the report. Secondly, the appendix provides a general overview of the topics and materials found in Volume 5.

The table below provides a list of the materials found in Volume 5 that are discussed in this report. Although surveys and interviews were designed to evaluate training, as well as to provide feedback on the BCR III issues, only one training survey and interview sheet are provided as samples. The first column in the table provides the title for each product. The second column (where indicated) states whether this appendix contains a partial or a complete sample of the product and the last column identifies the page number.

Volume Title	**Appendix Sample**	**Appendix Page**
Automated Measures Analysis for BCR III	Partial	F – 2
Training Surveys Analysis for BCR III	Partial	F – 3
Process Surveys Analysis for BCR III	Not Provided	--
Observer's Data Collection Instrument Analysis for BCR III	Partial	F – 5
Interviews for BCR III	Partial	F – 6

BCR III Automated Measures Data Analysis

MMBL Issue: Can reengineered Battle Command provide the information and support system to assist the Commander's decision making process?

Measure of Performance (MOP) 1: Measure of UAV Mission Effectiveness

Operational definition: For each UAV launch, calculate the % of OPFOR vehicles (by type [tank, IFV, APC, Arty, ADA, etc.]) that are first detected by the UAV under battalion control. A possible measurement method is the number of OPFOR vehicles first detected by UAV missions divided by the total number of OPFOR vehicles detected by all other sensors and weapon systems. UAV sensor capabilities will be determined by the parameters established for the system prior to the start of the experiment. The UAV flight path will be determined by experimental unit personnel.

Why: The SC4 system enables the commander to visualize the battlefield more effectively. This should include the ability to visualize the information terrain and appreciate regions of the battlefield where information is incomplete or non-existent. If they are being used effectively, UAVs should be sent to those areas of interest that are not already being covered by other sensors. If they are sent to areas of interest already covered by sensors, then a case can be made that either the SC4 system is not helping the commander better visualize the battlefield or the commander does not trust the situational awareness depicted by the SC4 system.

Data:

Experiment Total				Detected by						
Type		Expected		All	MUAV(Sct Plt)	%	UAV (Bn)	%	Combined	%
Tanks		215		126	39	31%	1	1%	40	32%
IFV		408		336	130	39%	48	14%	178	53%
APC		92		70	35	50%	15	21%	50	71%
Arty		264		153	51	33%	34	22%	85	56%
ADA		24		17	3	18%	0	0%	3	18%
Total		1003		702	258	37%	98	14%	356	51%

Analysis: Overall, the squadron detected 70% of all OPFOR vehicles arrayed against them. UAV missions accounted for 51% of the first detections which indicates that the squadron was employing their UAVs in a manner that would increase their ability to visualize the battlefield. Of significance is that the Micro UAVs (MUAV) which were controlled by the scout platoon first detected over twice the number of OPFOR vehicles than the squadron level UAV. This is explained by a programming error that gave the MUAV the same detection capability and a range/endurance that would allow the scout platoon to cover much more of the battlefield than had been originally intended.

Training Survey TDX 4 File Information

Variable Name	
GROUP	Audience Member Type Measurement Level: Nominal Value Label 1 Primary Audience 2 Extended Audience
ID	ID Number Measurement Level: Nominal
Q1	Prior Training Prepared Me for This TDX Measurement Level: Ordinal Value Label 1.00 Strongly Disagree 3.00 Neither Disagree nor Agree 5.00 Strongly Agree
Q2	Prior TDXs Prepared Me for This TDX Measurement Level: Ordinal Value Label 1.00 Strongly Disagree 3.00 Neither Disagree nor Agree 5.00 Strongly Agree
Q3	TDX Provided Good Chance to Use SC4 System Measurement Level: Ordinal Value Label 1.00 Strongly Disagree 3.00 Neither Disagree nor Agree 5.00 Strongly Agree
Q4	Tactical Materials Provided Enough Information Measurement Level: Ordinal Value Label 1.00 Strongly Disagree 3.00 Neither Disagree nor Agree 5.00 Strongly Agree

Training Survey TDX 4 File Information, cont.

Q5 Pre-Action Analysis Useful in Working as a Team
Measurement Level: Ordinal

Value	Label
1.00	Strongly Disagree
3.00	Neither Disagree nor Agree
5.00	Strongly Agree

Q6 Pre-Action Analysis Helpful in Future Training
Measurement Level: Ordinal

Value	Label
1.00	Strongly Disagree
3.00	Neither Disagree nor Agree
5.00	Strongly Agree

Q7 Commander's Timeout Useful in Working as a Team
Measurement Level: Ordinal

Value	Label
1.00	Strongly Disagree
3.00	Neither Disagree nor Agree
5.00	Strongly Agree

Q8 Commander's Timeout Helpful in Future Training
Measurement Level: Ordinal

Value	Label
1.00	Strongly Disagree
3.00	Neither Disagree nor Agree
5.00	Strongly Agree

Q9 Team Decision-Making Debrief Useful in Working as a Team
Measurement Level: Ordinal

Value	Label
1.00	Strongly Disagree
3.00	Neither Disagree nor Agree
5.00	Strongly Agree

Q10 Team Decision-Making Debrief Helpful in Future Training
Measurement Level: Ordinal

Value	Label
1.00	Strongly Disagree
3.00	Neither Disagree nor Agree
5.00	Strongly Agree

Observer's Data Collection Instrument File Information

Variable Name		
NODE	Measurement Level: Scale	
	Value	Label
	1.00	Command 1
	2.00	Command 2
	3.00	Control 1
	4.00	Control 2
DAY	Mission Day Measurement Level: Scale	
	Value	Label
	2.00	Experiment Day 2
	3.00	Experiment Day 3
	4.00	Experiment Day 4
	5.00	Experiment Day 5
	6.00	Experiment Day 6
	7.00	Experiment Day 7
SESSION	Measurement Level: Scale	
	Value	Label
	1.00	Morning
	2.00	Afternoon
QUESTION	Measurement Level: Scale	
RATING	Measurement Level: Scale Missing Values: 999.00	
	Value	Label
	1.00	Poor Performance
	7.00	Excellent Performance
B_NUM	Behavior Type Measurement Level: Scale	
	Value	Label
	1.00	Backup
	2.00	Communication
	3.00	Coordination
	4.00	Monitoring
	5.00	Team Orientation
	6.00	Overall

Interviews

Source	Topic	Comments/Observations/Thoughts from Interviews
Question: Did the training and practice (Levels 2-5) during Week 1 get you and your staff proficient enough to use the SC4 system during the experiment?		
Cmd Grp	Pace	He would have liked to see a higher tempo during the TDX phase.
Cmd Grp	Pace	He thought that revving up the motor and pushing hard, then resetting if necessary, would have provided better training.
Cmd Grp	Practice	Knew how system worked. Needed more TDXs. More time on the computers. Needed time playing with switches.
Cmd Grp	RA	Look at getting more proficient RAs. They have to be the experts.
Cmd Grp	Scenario	He would have liked to see a more continuous operating environment in the TDXs as well. By this he meant, more continuous execution of training rather than periodically stopping, having an AAR, and pre-briefing the next TDX as called for in the training plan.
Cmd Grp	TTS	Information class was a waste of my time! Most of the participants have had class on information management in AOB, AOAC, BNCOC, ANCOC, etc. Don't need it here as well. It was two hours I could have been sitting behind a computer screen practicing with the SC4 and ModSAF and things. I just did not see the need for that. It was a waste, a big waste.
Cmd Grp	Topics	Technically training was sufficient, but could have been better but he wasn't sure if he missed (through inattention) some things.
Cmd Grp	Practice	There was not enough training. More practice drills are needed.
Cmd Grp	Structure	After the second week, the participants had no problem with the system.
Cmd Grp	Brief	The PowerPoint slides of the equipment were not particularly helpful.
Cmd Grp	Flow	Did not know one level from the other.
Did the training and practice (Levels 2-5) get you and your staff comfortable and proficient in working within the new staff organization?		
Cmd Grp	Multi	Making and changing overlays was a problem. Who was supposed to make the changes was not spelled out. Commander expected future to make changes, even on current graphics.
Cmd Grp	Multi	Part of the system are supposed to make things easier, but we were still trying to fight the old fashioned way. That goes back to getting used to what the technology can do for you.